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AN ANALYSIS OF THE FERTILIZER INDUSTRY OF WESTERN CANADA

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled An Analysis of the Fertilizer Industry of Western Canada submitted by Arthur Thomas Stanley Collier in partial fulfilment of the requirements for the degree of Master of Business Administration.

ABSTRACT

This study is concerned with the historical growth, present situation and future prospects for the nitrogen-phosphate fertilizer industry of western Canada. The fertilizer industry has become a significant force in the economy of western Canada and therefore an in-depth study of it is worthwhile.

The investigative technique utilized in this study was documentary research. This research was carried on during a two year period between September 1967 and December 1969, both in Canada and the United States.

An analysis of the data collected resulted in the following major conclusions:

1. A combination of factors, rather than one single factor, has resulted in the establishment of the various fertilizer complexes in western Canada.

2. Over eleven thousand persons in western Canada are directly dependent upon the fertilizer industry.

3. The influence of the fertilizer industry has been more pronounced in Alberta than any of the other western provinces. By value of manufactured shipments the fertilizer industry ranks number six in Alberta's economy.

4. There is strong evidence that fertilizer manufacturers are employing the mechanics of a multiple basing point pricing system in marketing their products in western Canada.

5. Three interrelated factors; the trend to larger plants, changing marketing techniques, and the trend to higher analysis fertilizers are changing the structure of the fertilizer industry.

6. All markets, served by the fertilizer manufacturers of western Canada, are presently characterized by over-supply conditions. These over-supply conditions are expected to persist well into the 1970's.

ACKNOWLEDGEMENTS

The writer gratefully acknowledges the counsel and guidance of his supervisor, Dr. C. Hoskins. Dr. Hoskins' task was complicated by the fact that considerable communication had to be conducted by mail and long distance telephone. My sincere thanks also to Professor T. Earl, Dr. S. Drugge, Mr. J. Gregory and Mr. H. Ford, for their generous assistance.

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CHAPTER I

INTRODUCTION

1: OBJECTIVES OF STUDY

The purpose of this thesis is to analyze the nitrogen-phosphate industry of western Canada. Officials of the Government of Alberta and the Research Council of Alberta advised the author that a study outlining the past, present and future prospects for the fertilizer industry in western Canada would be of use to them in making intelligent policy decisions. The author also had discussions and correspondence with officials of various firms in Canada and the United States who also indicated that they would value a comprehensive study on western Canada's fertilizer industry. Numerous questions about this fertilizer industry needed answering. Why are the fertilizer plants located in various areas of western Canada? What was the basis for establishing each fertilizer plant? In what markets do western Canadian fertilizer manufacturers sell their products? How do fertilizer companies market their products in the various markets they serve? What is the zone-pricing system utilized in western Canada? What factors affect the demand for fertilizers?

What are the future prospects for the fertilizer industry in western Canada? All these questions need answering if intelligent reasoning is going to be applied by government and industry officials who are interested in the future prospects of the nitrogen-phosphate fertilizer industry of western Canada. Therefore, the purpose of this thesis is threefold:

1. To analyze the development of the nitrogen-phosphate fertilizer industry of western Canada, and the companies involved in this industry.

2. To classify and consolidate in a meaningful form the statistics pertaining to the various markets served by western Canadian fertilizer manufacturers.

3. To consider the future prospects for the nitrogen-phosphate fertilizer industry of western Canada.

2: TERMS OF REFERENCE

The fertilizer industry of western Canada broadly defined comprises all manufacturers of three principal plant nutrients, nitrogen, phosphorus and potassium.[1] Since very little potassium is required by the soils of the Canadian prairies or the Great Plains region of the United States[2], the potash section of the western

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[1]For a detailed description of the term "potassium" and "potash" see page 7, and Appendix A.

[2]Canadian Imperial Bank of Commerce, "The Canadian Potash Industry," Commercial Letter Canadian Imperial Bank of Commerce, April, 1966, p. 7.

Canadian fertilizer industry is excluded from this thesis.

3: PLAN OF PRESENTATION

Chapter II is devoted to outlining the basic manufacturing steps involved in the production of nitrogen-phosphate fertilizers. The nitrogen-fixing processes are considered firstly, followed by a review of the significance of phosphate rock and the products from it that are used as raw materials in various fertilizer materials. Chapter III offers a complete review of the history, capital costs, raw material sources, plant capacities and production figures for all the nitrogen-phosphate fertilizer plants located in western Canada. The chapter concludes with an examination of the importance of the fertilizer industry to the economy of western Canada. Chapter IV is concerned with an evaluation of the domestic and foreign markets for western Canadian-made fertilizers, and Chapter V analyzes the distribution techniques involved in marketing fertilizer in these various markets. The pricing system employed by manufacturers in western Canada is also discussed in Chapter V. Chapter VI analyzes the present supply-demand situations in the markets served by western Canadian fertilizer manufacturers; the changing structure of the industry and the prospects for future growth of the industry conclude the chapter.

4: TERMINOLOGY USED IN INDUSTRY

To facilitate understanding, some general terms used in the fertilizer industry are defined here; terms and definitions pertinent to specific subject matter will be outlined where warranted in later chapters. Appendix A contains a short description of the relative importance of the various nutrients to plant life.

Fertilizer

A fertilizer is any substance or material which, if added to the soil, increases or maintains the yield from the land.[3] Over the years, chemical materials have been developed which, although they are not derived from living organisms as is the case with "natural" or "organic" fertilizers, provide essential nutrients to plants. These chemical materials are termed "artificial", "inorganic", or "chemical" fertilizers, and they may be divided into three principal groups, nitrogen, phosphorus, or potassium. Throughout this thesis, "fertilizer" will denote inorganic chemical material unless otherwise noted.[4]

Fertilizer Grade

Grade means the percentage content of total nitrogen,

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[3] Peter Collins, Fertilisers (London: Overseas Development Institute, 1963), p. 15.

[4] Strictly speaking, two chemically-produced nitrogeneous fertilizers, calcium cyanamide and urea, are classified as organics because they contain carbon. These two chemically-produced organics are included under the term "fertilizer" in this paper.

available phosphoric acid, and soluble potash stated in that sequence. For example, the letters N, P and K, and the numbers 11-48-0 found on fertilizer bag labels denote the amount of the above mentioned materials. An 11-48-0 fertilizer contains 11 per cent nitrogen, 48 per cent available phosphoric acid and no soluble potash. One ton (2,000 pounds) of this material then contains 59 per cent or 1,180 pounds of total available plant nutrients.[5]

Fertilizer Material

A fertilizer material is any substance which contains one or two plant nutrient elements which are chemically combined. Examples of fertilizer materials are ammonia (82-0-0), ammonium phosphate (11-48-0), ammonium sulphate (21-0-0), ammonium nitrate (33-0-0).

Mixed Fertilizer

A mixed fertilizer is a blend of several fertilizer materials sold as one product.

Complete Fertilizer

A complete fertilizer is a mixed fertilizer containing all three primary plant nutrients, nitrogen, phosphorus and potassium.

Liquid Fertilizer

A liquid fertilizer is any liquid containing one or more available plant nutrients.

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[5] "Fertilizer Act," The Canadian Gazette, June, 1958, pp. 709-720.

Per cent

In the fertilizer industry, per cent means the per cent by weight.[6]

Phosphorus

The terminology of the fertilizer industry is not strictly correct chemically because the terms "phosphorus" and "phosphate" are used interchangeably. Also, the term "phosphoric acid" (H_3PO_4) is used for the phosphoric pentoxide (P_2O_5) content of fertilizers; phosphoric pentoxide contains 43.65 per cent phosphorus. In spite of criticism, the fertilizer industry continues this custom.[7]

Phosphate Rock

Phosphate rock is a commercial term for rock which contains one or more phosphate minerals, usually including calcium phosphate of sufficient grade and suitable composition to permit its use, either directly or after concentration, in manufacturing commercial phosphate products. Chemical analysis of phosphate rock is usually reported as a percentage of P_2O_5 or tricalcium phosphate, $Ca_3(PO_4)_2$, also known as B. P. L. (bone phosphate of lime); one per cent B. P. L. equals 0.458 per cent P_2O_5.[8]

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[6] Ibid., p. 710.

[7] G. H. Collings, Commercial Fertilizers: Their Sources and Use (5th ed.; New York: McGraw-Hill Book Co. Inc., 1955), p. 190.

[8] U. S., Bureau of Mines, Nitrogen, Bulletin No. 630 (Washington, D.C.: Government Printing Office, 1965), p. 701.

Potash

Although the term "potash" is often used interchangeably with potassium, "potash" in the fertilizer industry means water soluble potassium oxide (K_2O), which contains 83 per cent potassium. Muriate of potash (potassium chloride) is the common commercial form of potash, and when pure it contains 63.2 per cent potassium oxide by weight.[9]

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[9] Saskatchewan, Potash Committee, "World Supply and Demand for Potash and Its Impact on the Saskatchewan Industry," Regina, n.d., p. 4 (Mimeographed).

CHAPTER II

THE PRODUCTION OF CHEMICAL FERTILIZERS

1: INTRODUCTION

The purpose of this chapter is to briefly outline the steps involved in manufacturing chemical fertilizers. All fertilizers containing nitrogen are dependent on the successful fixation of nitrogen from the atmosphere, and therefore the various nitrogen-fixing processes will be discussed firstly. Fertilizers containing phosphorus are based on phosphate rock; however, there is presently no known commercially significant deposit of phosphate rock in western Canada, and therefore, the second section of the chapter will consider the foreign phosphate rock sources and suppliers for western Canada. Nitrogen and phosphorus are the basis for many fertilizer materials and fertilizer mixtures; the final sections outline briefly the steps involved in the manufacture of these materials and mixtures.

2: NITROGEN-FIXING PROCESSES

There are three basic nitrogen-fixing processes with which

the fertilizer industry is primarily concerned: the "arc process", which produces dilute nitric acid; the "cyanamide process", which produces calcium cyanamide; and the "synthetic ammonia process", which produces ammonia.[1] Each of these methods will be considered in turn.

a. The Arc Process

The arc process is the simplest method of nitrogen fixation and was the first process to be developed commercially. However, little progress has been made since World War I in increasing the world's nitrogen-fixation capacity by this process.[2] A detailed description of the reactions taking place in the arc process is found in Appendix B.

There are two principal objections to the arc process. Firstly, the process requires tremendous quantities of electricity. Secondly, because of the high capital costs involved, it cannot compete with the less expensive ammonia fixation process. In view of the development of other processes for nitrogen fixation, these two objections to the arc process preclude it as a possible large producer of fixed nitrogen in most countries; however, a modification of the arc process has been successfully used in the Scandinavian countries

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[1] S. L. Tisdale and W. L. Nelson, Soil Fertility and Fertilizers (New York: Macmillan Co., 1956), p. 129.

[2] Collings, Commercial Fertilizers, p. 78.

because of low-cost hydroelectric power.[3]

b. The Cyanamide Process

During World War I, the cyanamide industry developed rapidly because cyanamide nitrogen can be converted into ammonia gas and then into nitric acid for use in explosives.[4] Calcium cyanamide is produced in four separate steps as outlined in Appendix B.

Although the cyanamide process has several advantages over the arc process, serious drawbacks still hinder its use. Even though the cyanamide process uses only about one-fifth the electricity required by the arc process, its electrical power requirements are still high; also, although relatively inexpensive, very large amounts of coke are required. Employment of this process is limited, therefore, to areas which have an abundant supply of both electrical energy and coke.

The only operational cyanamide plant in North America, at Niagara Falls, produces about 250,000 tons of cyanamide a year, part of which is shipped to the United States. Used extensively as a fertilizer during the early part of this century, calcium cyanamide today represents only about 2.5 per cent of the nitrogeneous fertilizers consumed in the world.[5]

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[3] Ibid., p. 79.

[4] Ibid., p. 80.

[5] Ibid., p. 81.

c. The Direct Synthetic Ammonia Process

Developed after the arc and cyanamide processes, the direct synthetic ammonia process has become the most common method of nitrogen fixation and it has almost completely replaced the former methods.[6] The first commercial synthetic ammonia plant was completed in 1913 in Germany, and the first steam-methane process plant in 1941 in Alberta, Canada.[7]

Although the arrangements for ammonia synthesis and equipment design are varied today, due to the many modifications which have taken place over the years, the process of ammonia synthesis still comprises three principal steps:

1. The preparation of hydrogen and nitrogen.
2. The purification and compression of the hydrogen and nitrogen gasses produced.
3. Ammonia formation by the synthesis of these two gases under conditions of high pressure and temperature in the presence of a suitable catalyst.[8]

Each of the above steps is considered in detail in Appendix B. In the synthesis process, ammonia is the economical means for the

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[6] Ibid., p. 81.

[7] A. D. Wilkinson, "The Effect of Natural Gas on the Growth of Western Canada's Fertilizer Industry" (paper presented to Symposium on Alberta Petrochemical Industry, Edmonton, March, 1962), p. 169.

[8] K. D. Jacob, ed., Fertilizer Technology and Resources in the United States, Vol. III (New York: Academic Press Inc., 1953, pp. 34-40.

fixation of atmospheric nitrogen, and is the principal commercial compound of nitrogen. Although ammonia itself, either as a liquid or a gas, is a useful fertilizer compound, its conversion into other useful fertilizer compounds will be considered later in this chapter.

3: MAJOR PHOSPHATE ROCK RESOURCES

Phosphate rock deposits occur in many countries throughout the world, but the largest known deposits and those presently of greatest economic importance are in North America (USA), Europe (USSR), and North Africa (Morocco, Tunisia, Algeria). It is unlikely that world reserves of phosphate rock will ever be depleted because the present known reserves of over 55 billion tons are sufficient to last at least 1,000 years at current consumption rates. Nearly 30 per cent of the known phosphate rock reserves occur in the United States (see Figure 1).[9]

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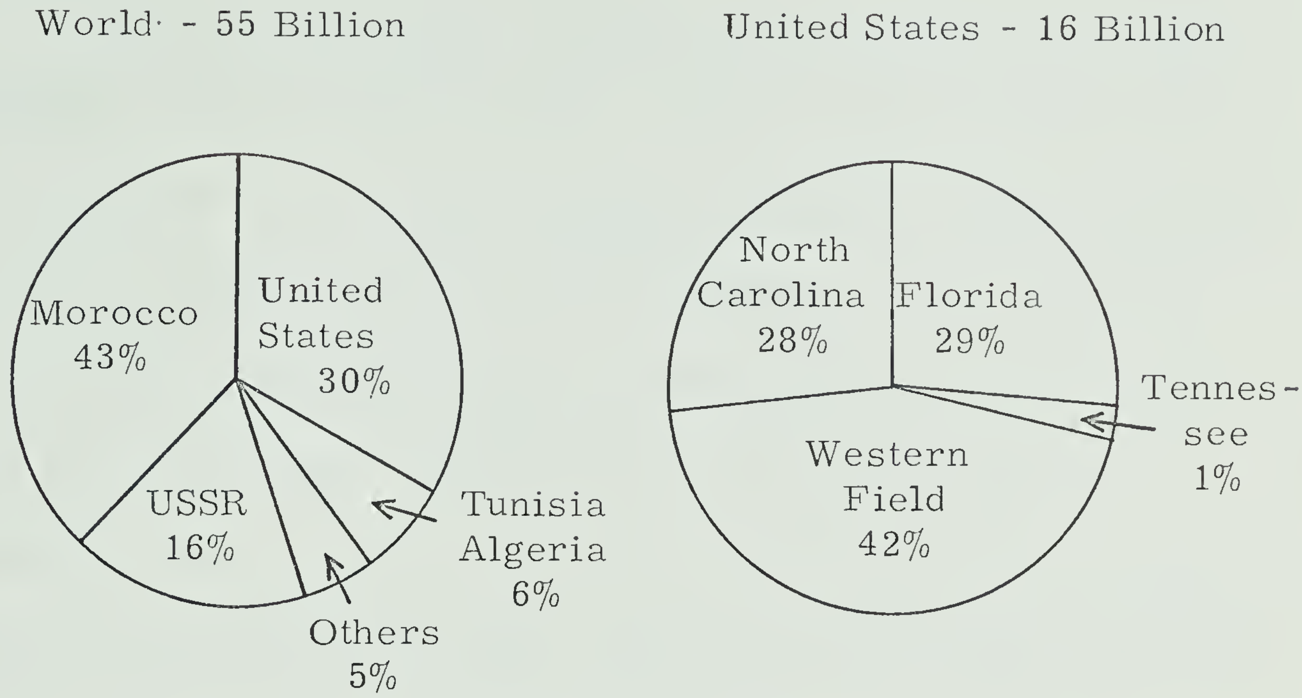
[9] J. V. Beall, "Phosphate Rock in the United States: A High Bulk Low Value Commodity," Mining Engineering, October, 1966, p. 81.

FIGURE 1

Reserves of Phosphate Rock - Tons



Source: Beall, "Phosphate Rock," p. 81.

Although considerable interest has been shown in the apatite[10] deposits of Ontario and Quebec during the last few years, commercial mining of phosphate rock is not carried out in Canada at the present time. Imperial Oil Limited is now carrying out an intensive exploration program in the Fernie area of southeastern British Columbia to determine if the apatite deposits there warrant commercial exploitation. To date, no development has been made for an economic method of processing Canadian apatite into fertilizer or industrial products capable of competing with the high-grade phosphate rock available to Canadian fertilizer plants (duty-free) from Florida or

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[10] Apatite is essentially calcium phosphate.

the western United States. The western Canadian fertilizer industry is therefore dependent on imported phosphate rock from the United States.

In the United States, phosphate rock is mined in Florida, Tennessee, North Carolina, Idaho, Montana, Utah, and Wyoming. The latter four states comprise what is termed the "western field", centered in southeastern Idaho and extending into Utah, Montana and Wyoming, and comprising one of the largest deposits of phosphate ore in the world. Geologically, the western deposits are complex in their pattern of occurence; in some instance, they are so deeply imbedded as to require shaft mining operations, while in other instances, they occur near the surface and may be strip-mined.[11] A complete list of phosphate mines in the United States, as well as operating companies, locations and capacities, is presented in Table 1. The economics of western phosphate rock and thereby phosphate fertilizers have been largely determined by Florida producers, as Florida rock has historically captured fertilizer markets in the Central Plains States, and more recently has made inroads into the California and western Canadian markets.

4: THE MANUFACTURE OF SOME IMPORTANT FERTILIZER MATERIALS

Figure 2, page 17 shows diagrammatically how synthetic

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[11] Tisdale, Soil Fertility, p. 157.

ammonia and phosphate rock, together with sulfuric acid, phosphoric acid and nitric acid, are used as raw materials in the production of various fertilizer materials. All the chemical processes and reactions referred to in this section are explained in detail in Appendix B.

TABLE 1

Phosphate Rock Producers and Their Mine Locations in the United States

Company	Location	Capacity (Dec. 31, 1967) (thousand short tons)
	Florida:	
American Cyanamide Company	Brewster	3,650
Armour Agricultural Chemical Co.	Armour, Lake Hancock	1,500
Armour Agricultural Chemical and Freeport Sulphur Corporation	Ft. Meade	2,000
Borden Chemical Company	Teneroc	1,500
Cities Service Company	Ft. Meade	2,000
Continental Oil Company	Pierce	6,500
W. R. Grace & Company	Bonny Lake	1,550
International Minerals & Chemical Co.	Bonnie	6,000
	Kingsford	2,000
Kerr-McGee, Incorporated	Brewster	1,500
Mobil Chemical Company	Ft. Meade	5,700
Occidental Agricultural Corporation	White Springs	3,000
Swift & Company	Watson, Silver City	2,325
	North Carolina:	
Texas Gulf Sulphur Corporation	Lee Creek	3,000
	Tennessee:	
Armour Agricultural Chemical Co.	Columbia	90

Company	Location	Capacity
	Tennessee: (cont'd.)	
Hooker Chemical Company	Columbia	750
Mobil Chemical Company	Mt. Pleasant	200
Monsanto Company	Columbia	1,000
Presnell Phosphate Company	Columbia	700
Stauffer Chemical Company	Mt. Pleasant	600
Tennessee Valley Authority	Knob Creek, Franklin	200
	Western States:	
Cominco Ltd.	Garrison, Phillipsburg (Montana)	1,050
El Paso Natural Gas Company	Soda Springs (Idaho)	400
Monsanto Company	Ballard (Idaho)	500
Mountain Fuel Supply Company	Soda Springs (Idaho)	...
New Idria Mining & Chemical Co.	Bakersfield (California)	...
George Relyea	Garrison (Montana)	100
J. R. Simplot Company	Ft. Hall, Soda Springs (Idaho)	1,600
Stauffer Chemical Company	Hot Springs, Montpelier (Idaho)	200
	Cherokee (Utah)	400
	Vernal (Utah)	200
	Leefe (Wyoming)	350
	Melrose (Montana)	600
Total United States		51,165

... Data unavailable

Source: Edwin A. Harre, Fertilizer Trends - 1967 (Muscle Shoals, Alabama: Tennessee Valley Authority, 1967), p. 35.

FIGURE 2

The Basic Processes Used in the Manufacture of
Some Selected Fertilizer Materials

	Sources	Process	Product
A	Phosphate Rock	Grind to about .1 millimeter	Ground Phosphate Rock (0-35-0)
B	Sulphur Air Water	Catalytic Oxidation and Hydration	Sulphuric Acid
C	Phosphate Rock Sulphuric Acid	React and Cure or Dissolve and Filter	Normal Super-phosphates (0-20-0) Phosphoric Acid Gypsum
D	Phosphate Rock Phosphoric Acid	React and Cure	Triple Super-phosphate (0-48-0)
E	Hydrocarbons Steam Air	Re-Form to Hydrogen Synthesize Nitrogen From Air	Ammonia (82-0-0)
F	Ammonia Sulphuric Acid	React and Crystallize	Ammonium Sul-phate (21-0-0)
G	Ammonia Phosphoric Acid	React and Crystallize or Granulate	Ammonium Phos-phate (18-46-0)
H	Ammonia Air Water	Catalytic Oxidation Absorption	Nitric Acid
I	Ammonia Nitric Acid	React and Crystallize or Make into Pellets	Ammonium Nitrate (33-0-0)
J	Ammonia Carbon Dioxide	React and Crystallize or Make into Pellets	Urea (46-0-0)

Note: Each horizontal line shows the flow of the ingredient listed at left opposite the line. A vertical line shows a combining of ingredients.

Source: Christopher J. Pratt, "Chemical Fertilizers," Scientific American, June 1965, p. 68.

As outlined in Figure 2, there are two basic methods whereby phosphate rock is processed so that its phosphorus content is available[12] to plant life: grinding (Process A) and acid treatment (Process C). The simplest process of preparing phosphate rock for agriculture consists of grinding high grade rock to particles less than 0.1 millimeter in size. The mineral apatite, however, is very stable and quite insoluble in water, and therefore in its natural state, phosphate rock even in an extremely finely-ground condition is only of limited value to growing plants. In addition to the problem of availability, the phosphorus content of ground phosphate rock varies considerably. Sales of ground phosphate rock in Canada for direct application to the soil are negligible, totalling only 247 tons during the fertilizer year ended June 30, 1968.[13]

Dependent on sulphuric acid for many years because of the "wet process",[14] the fertilizer industry today consumes 55 per cent of the world's production of elemental sulphur and sulphur equivalent from pyrites and other sources. Due to lower costs of production over other mineral acids even in very small industrial

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[12] The term "available" means the percentage of phosphorus which can be used by plant life under the methods of analysis prescribed by the Association of Agricultural Chemists of North America.

[13] Canada, Dominion Bureau of Statistics, Fertilizer Trade, Catalogue 46-207 (Ottawa: Queen's Printer, 1968), p. 5.

[14] The "wet process" involves treating phosphate rock with sulphuric acid as outlined in Process C, Figure 2.

plants, sulphuric acid has remained the prime acidulent of phosphate rock.[15] The technology and economics of manufacturing sulphuric acid are better known and better defined than those of any other industrial chemical; sulphuric acid is made by two well known processes, the older "chamber process" and the newer "contact process" (Process B).

When finely-ground phosphate rock is reacted with sulphuric acid (Process C), the resultant product, if allowed to solidify, is known as normal superphosphate, which is a fertilizer containing from 16 to 22 per cent phosphorus equivalent. The phosphorus content of normal superphosphate is largely water soluble, making it a suitable source of phosphorus for most plants; also, because it contains sulphur, normal superphosphate is preferred on sulphur-deficient soils to more concentrated phosphatic materials without sulphur. The principal disadvantage of normal superphosphate is its relatively low phosphorus content compared to triple superphosphate which is discussed below.

"Wet-process phosphoric acid" is a term now used exclusively in the fertilizer industry to describe the impure phosphoric acid produced by the digestion of phosphate rock with sulphuric acid (Process C).[16] Wet-process phosphoric acid is used

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[15] David W. Bixby and others, Phosphatic Fertilizers: Properties and Processes, Technical Bulletin No. 8 (Washington, D. C.: The Sulphur Institute, 1966), p. 4.

[16] Ibid., p. 9.

for the manufacture of triple superphosphate and ammonium phosphate fertilizers. (Processes D and G). Triple superphosphate, as the name implies, usually contains from 43 to 48 per cent of the available phosphorus, or nearly three times as much as phosphorus as normal superphosphate.

Ammonium phosphates are made by neutralizing wet-process phosphoric acid with ammonia. The terms "monoammonium phosphate" and "diammonium phosphate" commonly are used because ammonium phosphate may be present as the monoammonium or the diammonium salt or a mixture of these two. Ammonium phosphates are highly concentrated (up to 74 per cent plant nutrient content) sources of water soluble plant food; they also have good chemical and physical properties, and may be applied to the soil directly or combined in many ways with other materials.[17]

Figure 2 shows diagrammatically how ammonia is combined with various other substances besides phosphoric acid, to make ammonium sulphate, nitric acid, ammonium nitrate and urea. Ammonium sulphate contains 24 per cent sulphur, in addition to 21 per cent nitrogen, thus making it an attractive fertilizer on soils which are deficient in both nitrogen and sulphur. Ammonium nitrate is an excellent source of nitrogen, and due to its composition and solubility, it is perhaps the quickest acting nitrogeneous

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[17]Tisdale, Soil Fertility, p. 134.

fertilizer known. Urea is becoming an increasingly popular fertilizer mainly because of its high nitrogen content (46 per cent nitrogen), and its good storage and handling properties.

5: THE MANUFACTURE OF MIXED FERTILIZERS

There are over ninety different kinds of mixed fertilizers sold in Canada today.[18] Mixed fertilizers may be manufactured by any one or a combination of three processes, chemical mixing, liquid mixing, bulk-blending or dry-mixing. Chemically-mixed fertilizers are prepared by chemically combining a solid phosphatic material (usually normal or triple superphosphate) with anhydrous ammonia or a nitrogen solution, and a solid form of potash; this chemical mixture may be granulated or sold in a pulverized form. The manufacture of liquid-mixed fertilizers involves the combination of raw materials to form a soluble solution containing plant nutrients; liquid-mixed fertilizers use phosphoric acid and diammonium phosphate as phosphorus sources. Bulk-blending or dry-mixing refers to the physical blending of two fertilizer ingredients; ammonium phosphates and superphosphates are commonly used in dry mixes.[19]

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[18] Dominion Bureau of Statistics, Fertilizer Trade, pp. 6-7.

[19] J. W. Brown, "Agricultural Phosphates in Canada 1962-1972," Canadian Mining and Metallurgical Bulletin, Sept. 1962, pp. 310-316.

CHAPTER III

AN ANALYSIS OF THE FERTILIZER PLANTS LOCATED IN WESTERN CANADA

1: INTRODUCTION

This chapter analyzes the supply side of the supply-demand equation for fertilizers in western Canada. A brief historical review of each fertilizer manufacturer in western Canada is considered first, followed by a discussion of the raw material inputs utilized by the fertilizer industry. The productive capacities of the various fertilizer complexes located in western Canada and the sales of fertilizer from these complexes are outlined next. The chapter concludes with a discussion of the significance of the fertilizer industry to the economy of western Canada.

2: HISTORICAL REVIEW OF THE COMPANIES INVOLVED IN MANUFACTURING FERTILIZERS

a. Cominco Limited

The Consolidated Mining and Smelting Company of Canada (now Cominco Limited) was formed in 1906 by the consolidation of a

small smelter and several nearby mines at Trail, British Columbia.[1] With the expansion of the metallurgical operations at Trail, increasing quantities of sulphur-bearing smoke were emitted into the atmosphere. Prevailing winds caused smoke damage to vegetation in the state of Washington, and subsequently an international tribunal assessed Cominco damages, in addition to requiring the company to control the smoke. As a result, a ten million dollar chemical fertilizer construction program was begun at Trail in 1930 based mainly on the usage of sulphur dioxide gas as a source of sulphuric acid in the manufacture of fertilizers.[2]

In 1939, at the request of the Canadian government, Cominco expanded its Trail ammonia plant and built new ammonia plants at Calgary and Trail. Cominco operated these plants for the government as munition plants during the Second World War. After the war, Cominco purchased both these plants for $7.5 million from the government and began manufacturing ammonium nitrate fertilizers in Calgary in 1946. Following the war, Cominco also undertook a $100 million expansion program, which included the establishment of a fertilizer plant at Kimberley, British Columbia, based on by-product sulphur dioxide gas from metallurgical operations at that

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[1] Cominco Limited, The Cominco Story (Trail, B.C.: Cominco Limited, n.d.), p. 4.

[2] Ibid., p. 5.

location.[3]

In 1959, Cominco commenced construction of a urea plant at Calgary, in addition to doubling the capacity of the Kimberley fertilizer operation. In 1965, further expansion of the Kimberley fertilizer plant enabled it to produce excess phosphoric acid for use in a new granulation plant at Regina, Saskatchewan, which Cominco had also built that same year. As outlined in Table 3, page 35 the annual fertilizer productive capacity of all Cominco's plants in western Canada totals 1.1 million tons.

b. Northwest Nitro-Chemicals Limited

The expanding market for fertilizers in western Canada was the prime reason for Northwest Nitro-Chemicals Limited being formed, strictly as a basic fertilizer producer, on August 9, 1954, under the laws of the Province of Alberta.[4] Construction of Northwest's fertilizer plant was completed in October, 1956, near Medicine Hat, Alberta. The availability of cheap natural gas, water, and sulphur from Alberta, plus phosphate rock from the western United States, made a Medicine Hat location favourable. Entry into the market was obtained by appointing a number of elevator companies as distributors, in competition with Cominco Limited, who had up to this time been a monopoly supplier to farmers in western

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[3] Ibid., p. 6.

[4] Moody's Investors Service Inc., Moody's Industrial Manual 1968 (New York: Robert H. Messner, 1968), p. 2389.

Canada.

In 1965, Northwest Nitro undertook an $8 million expansion program to double the ammonia capacity of their plant and also to increase the phosphoric acid capacity; this expansion program was prompted by Sherritt Gordon Mines Limited, which had been selling excess ammonia to Northwest Nitro, but was now utilizing more ammonia yearly at its plant at Fort Saskatchewan, Alberta. Early in 1968, Northwest Nitro announced plans for a further $1.5 million modification program of its plant, which has now added ammonium nitrate and a more varied form of ammonium phosphate to the product line.[5] The present total capital cost of the Northwest Nitro plant near Medicine Hat is $32.5 million[6], with an annual productive capacity of 235,000 tons of ammonium phosphate and nitrate fertilizers.[7]

c. Sherritt Gordon Mines Limited[8]

Sherritt Gordon Mines Limited entered into the manufacture

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[5] Alberta, Bureau of Statistics, Summary of General Statistics (Edmonton: Queen's Printer, 1968), p. 11.

[6] Canada, Department of Agriculture, Canadian Fertilizer Plant Statistics (Ottawa: Queen's Printer, 1967), p. 47.

[7] F. N. Graham-Yooll, "Canada's Fertilizer Industry and Its Transportation Problems," Chemistry in Canada, October, 1966, p. 30.

[8] The information on this company was derived from several pamphlets distributed by Sherritt Gordon Mines Limited, and a letter dated Dec. 3, 1968, from M. A. Schoening, Manager, Systems and Economics Department, to the author on the subject of the fertilizer complex of Sherritt Gordon Mines Limited.

of fertilizers to dispose of two excess products which were an integral part of their metal-leaching process. The decision to manufacture fertilizers was based on the problem of effectively using excess ammonia, which was required as a leaching agent for the metal-leaching process, and ammonium sulphate, which was a by-product of the metal-leaching process. Fertilizer market considerations were not the prime reasons Sherritt built its plant at Fort Saskatchewan, Alberta, in 1954. Cheap natural gas as a source of ammonia for the metals-processing plant was the most important reason for the plant's location at Fort Saskatchewan, as well as adequate supplies of water from the North Saskatchewan River. The site was also desirable because it was relatively close to Sherritt's ore deposit at Lynn Lake, Manitoba, and was served by the Canadian National Railways, which had agreed to build a $15 million rail line in Manitoba for the transportation of Sherritt's raw ore to the eventual refining plant.

The ammonia plant at Fort Saskatchewan has been expanded over the years so that Sherritt could increase its production of ammonium sulphate and undertake the production of urea. The urea plant was completed in 1962. Construction was also begun on facilities to add phosphate-type fertilizers to their product line, with the first shipment being made in August of 1965. Sherritt's present Fort Saskatchewan operation is an integrated metal-refining fertilizer-manufacturing complex built at a capital cost of $67 million.

d. Western Co-operative Fertilizers Limited[9]

This company is the corporate expression of a three-way partnership of Federated Co-operatives Limited and the Alberta and Saskatchewan Wheat Pools. Federated Co-operatives is a wholesale organization established by the five hundred retail co-operative stores it supplies in the three prairie provinces, and the Alberta and Saskatchewan Wheat Pools are owned by the farmers they serve.

The Western Co-operative Fertilizers' plant was officially opened October 9, 1965, in southeast Calgary, at a capital cost of $24 million. The establishment of this fertilizer complex was warranted by the large captive market provided by the retail stores of Federated Co-operatives and farmer members of the Alberta and Saskatchewan Wheat Pools. Calgary was chosen as the plant site after consideration was given to both effectively serving the western Canadian prairie market, and the cost and source of the various raw materials required. Western Co-operative Fertilizers Limited's plant at Calgary has a rated annual capacity of 225,000 tons of various ammonium phosphates and nitrates, and is Canada's

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[9] Western Co-operative Fertilizers Limited, Welcome to Co-op Fertilizers Calgary Plant (Calgary: Western Co-operative Fertilizers Limited, n.d.).

Plus a letter dated Dec. 2, 1968, from K. E. Nielsen, Director of Planning and Product Development, to the author on the subject of the fertilizer complex of Western Co-operative Fertilizers Limited.

only fertilizer company owned by its customers through their co-operative organizations.

e. Simplot Chemical Company Limited

Simplot Chemical Company Limited is a wholly-owned subsidiary of the J. R. Simplot Company, Pocatello, Idaho. Construction of Simplot's fertilizer plant near Brandon, Manitoba, commenced in the summer of 1965, with the plant fully operational by June, 1967, at a total capital cost of $30 million.[10] The fertilizer complex was established in Manitoba as a result of two factors, low cost loans and a growing market. Officials of the Manitoba government were anxious to see a fertilizer plant established in the province, and they approached the J.R. Simplot Company with a proposal to meet this objective; their proposal included low-cost loans from the Manitoba Development Fund, and the possiblity of a non-repayable grant from the Dominion Government if the fertilizer plant was constructed in a designated area under the terms of the Area Development Act. In addition to low-cost financing, the western Canadian prairie market and the mid-western United States fertilizer market (where the J.R. Simplot Company already has a distribution system established) could be served from a Manitoba location. Under the terms of the Area Development Act, Simplot will eventually receive approximately $5 million in non-repayable

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[10] C. J. V. Murphy, "Jack Simplot and His Private Conglomerate," Fortune, August, 1968, p. 166.

grants from the Canadian Government. The Manitoba Development Fund supplied $20 million on a long term low-cost loan, and the J.R. Simplot Company provided $5 million towards the total cost of the fertilizer complex in Manitoba.[11] Having a rated annual capacity of 340,000 tons of fertilizer, the Simplot fertilizer plant produces ammonium phosphates, nitrates and urea.[12]

f. Imperial Oil Limited

Imperial Oil Limited first began selling its "Engro" brand fertilizers in the three prairie provinces through a five year supply contract with Cominco Limited in 1964. The expansion into fertilizers by Imperial Oil Limited was based on the increasing use of fertilizers by prairie farmers and the fact that Imperial Oil had a strong existing network of petroleum farm agents who held more than one-third of the market for farm petroleum products in western Canada.[13]

In April, 1967, Imperial Oil Limited announced plans to build a fertilizer plant south of Redwater, Alberta, which was a designated area under the terms of the Canadian government's Area Development Act. Imperial Oil was allowed a $5 million non-repay-

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[11] Ibid., p. 171.

[12] Letter dated Jan. 30, 1969, from D. Travis Jr., Sales Manager, to the author on the subject of the fertilizer complex of Simplot Chemical Company Limited.

[13] Imperial Oil Limited, "Plans for Engro," Perspective, December, 1965, p. 2.

able grant on their $60 million fertilizer complex completed in June, 1969; the opening of this fertilizer plant coincided with the termination of the contract between Imperial Oil and Cominco. Total annual output of the complex has been set at 500,000 tons of ammonium phosphate, ammonium nitrate and nitrogen solutions.[14]

g. Border Fertilizer Limited

This company's plant located near Winnipeg, Manitoba, opened in October, 1964, at a capital cost of $2.5 million. Border Fertilizer Limited was formed as a result of two factors. Firstly, its parent company, Border Chemical Limited, manufactured sulphuric acid, a primary fertilizer ingredient. Secondly, Manitoba Pool Elevators agreed to become an equal partner with Border Chemical Limited in the construction of a fertilizer plant.[15] This fertilizer complex is presently not operating; however, it does have a potential annual productive capacity of 100,000 tons of ammonium phosphates.

3: RAW MATERIALS UTILIZED BY THE FERTILIZER INDUSTRY

Table 2 outlines the amount of phosphate rock, sulphur, natural gas and water utilized daily by each fertilizer manufacturer

[14] Letter dated Feb. 28, 1969, from G.W. Carter, Manager, Agricultural Chemicals Division, to the author on the subject of the fertilizer complex of Imperial Oil.

[15] Manitoba Newsletter Bulletin, November-December, 1964, p. 9.

in western Canada. An examination of Table 2 reveals that a total of 5,250 tons of phosphate rock is consumed daily by six of the eight fertilizer manufacturers in western Canada. Cominco Limited's Calgary plant does not manufacture phosphate-type fertilizers, and therefore uses no phosphate rock. Simplot Chemical Company Limited is supplied with phosphoric acid from Idaho by its parent company, the J.R. Simplot Company.

TABLE 2

The Daily Requirements of the Major Raw Materials Utilized By the Fertilizer Manufacturers of Western Canada

Company	Phosphate Rock		Sulphur		Natural Gas		Water	
	Tons	Source	Tons	Source	000's Cubic Feet	Source	000's Gallons	Source
Cominco								
Calgary	0	-	0	-	14,000	Alberta	40,000	Bow River
Kimberley	1,200	Montana	0	(1)	1,100	Alberta	10,800	St. Mary R.
Trail	800	Montana	0	(1)	6,500	Alberta	n/a	Columbia R.
Northwest Nitro	600	Idaho	200	Alberta	11,000	Alberta	1,000	Aquifer
Sherritt Gordon	430	Florida	530(2)	Alberta	24,000	Alberta	2,600	N. Sask. R.
Imperial Oil	1,500	Florida	600	Alberta	24,000	Alberta	6,000	N. Sask. R.
Western Co-op	720	Florida	200	Alberta	9,000	Alberta	1,000	Bow River
Simplot Chemical	(3)	Idaho	n/a	(4)	12,000	Alberta	n/a	Assiniboine River
Total Daily Consumption	5,250	-	1,530	-	101,600	-	55,400	-

Notes: (1) Utilize sulphur dioxide gas from metal plant.
(2) Sherritt Gordon Mines Limited purchase sulphuric acid from Inland Chemicals Limited at Fort Saskatchewan, Alberta.
(3) Simplot Chemical Company purchases phosphoric acid from the J.R. Simplot Company in Idaho.
(4) Simplot Chemical Company purchases sulphuric acid from Border Chemical Limited in Manitoba.
n/a means information not available

Source: Private correspondence with each company.

Imperial Oil Limited's fertilizer plant, now operational, is only the third plant (in addition to Northwest Nitro-Chemicals Limited and Western Co-operative Fertilizers Limited) in western Canada to purchase sulphur for the manufacture of ammonium phosphate and sulphate fertilizers. As outlined in Table 2, Sherritt Gordon Mines Limited and Simplot Chemical Company Limited purchase sulphuric acid from Inland Chemicals Limited and Border Chemical Limited respectively; both of these latter two companies rely on Alberta sulphur supplies for their needs. Cominco Limited's Calgary plant does not manufacture fertilizers requiring sulphuric acid, and Cominco's fertilizer plants at Trail and Kimberley both rely on by-product sulphur dioxide gas, from metal-processing operations, as a source of sulphur for eventual conversion into sulphuric acid.[16]

Over 100 million cubic feet of natural gas are consumed daily by the fertilizer manufacturers in western Canada, and therefore, low-cost natural gas is of prime importance to the fertilizer industry because of the large volume consumed. Although water is needed in large quantities, it is used mainly for cooling purposes and then returned to the source with negligible loss.

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[16] "Cominco Comes Out of the Hills," Chemical Week, Dec. 14, 1963, p. 57.

4: FERTILIZER PLANT CAPACITIES AND SALES

Table 3 shows that the present potential productive capacity of all the fertilizer plants in western Canada is approximately 2.9 million tons annually. It should be noted that the plants of Border Fertilizer Limited and Cominco Limited, Regina, are not presently manufacturing fertilizers; however, these two complexes still represent potential capacity, and are therefore included in Table 3. An examination of Table 3 outlines that even with the entry of Imperial Oil Limited into manufacturing this year, Cominco Limited, with its four fertilizer plants capable of producing over one million tons of fertilizer per year, continues to rank number one in productive capacity in western Canada. Cominco's four fertilizer complexes represent about 38 per cent of the total productive capacity in western Canada, whereas Imperial Oil Limited accounts for 18 per cent of the total; no other company represents more than 13 per cent. A perusal of Table 3 also reveals that approximately 60 per cent, or 1.7 million tons, of the total fertilizer productive capacity in western Canada is devoted to the manufacture of various types of ammonium phosphate fertilizer.

TABLE 3

The Annual Potential Productive Capacity by Type of Fertilizer, Western Canada Fertilizer Plants
July, 1969

Company	Ammonium Phosphate	Ammonium Nitrate	Ammonium Sulphate	Urea	Nitrogen Solution	Total
			(thousands of tons)			
Cominco Ltd.						
Calgary, Alberta	-	65	-	90	20	175
Kimberley, B.C.	166	-	-	-	-	166
Regina, Saskatchewan	83	-	-	-	-	83
Trail, B.C. (1)	315	130	210	-	-	655
Total Cominco	564	195	210	90	20	1,079
Northwest Nitro (1)	175	60	-	-	-	235
Sherritt Gordon	125	-	120	100	35	380
Western Co-op	160	65	-	-	-	225
Imperial Oil Ltd.*	365	100	-	-	35	500
Border Fertilizer Ltd.(1)	100	-	-	-	-	100
Simplot Company	220	90	-	30	-	340
Total Capacity of Plants in Alberta	825	290	120	190	90	1,515
Alberta as a Percentage of Total	48.3%	56.9%	36.4%	86.4%	100%	53.0%
Total Capacity of Plants in Western Canada	1,709	510	330	220	90	2,859

* Note: The capacity of the Imperial Oil Limited complex became available in June, 1969.

Source: Private correspondence with all companies except as noted below:
(1) Graham-Yooll, "Canada's Fertilizer Industry," p. 30.

Table 4 shows a comparison of the total fertilizer sales reported by western Canadian manufacturers (in all markets) and the actual consumption of fertilizer in western Canada. Western Co-operative Fertilizers Limited sell all their output in western Canada, and therefore supply fertilizers to approximately 20 per cent of the western Canadian market. Sales of fertilizers by Imperial Oil Limited are not included in Table 4 because up to June, 1969, as previously outlined, Cominco Limited supplied Imperial's needs; therefore, total sales figures for Cominco include sales to Imperial Oil Limited. Imperial Oil Limited reportedly has 15 per cent of the western Canadian market;[17] therefore, annual sales of fertilizer by this company in western Canada in 1967 probably totalled about 135,000 tons. Officials of Cominco Limited state that 60 per cent of their total sales of fertilizers are exported,[18] which means in 1967 Cominco Limited sold approximately 400,000 tons of fertilizer in western Canada. However, Imperial Oil Limited accounted for 135,000 tons of Cominco's total sales, and therefore Cominco Limited actually sold 265,000 tons of "Cominco Brand" fertilizers in western Canada in 1967, or about 29 per cent of total sales. Sherritt Gordon Mines Limited has contracted to supply all

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[17]"Imperial Shows Muscle in Fertilizer Markets," Alberta Business Journal, January-February, 1969, p. 44.

[18]Cominco Limited, Cominco Annual Report 1967 (Montreal: Cominco Limited, 1968), p. 3.

TABLE 4

A Comparison of Fertilizer Consumption in Western Canada with the Total Fertilizer Sales*
Reported by Western Canadian Manufacturers, 1963-1967

Year	(1) Sales by Cominco Limited	(2) Sales by Northwest Nitro-Chemicals Limited	(1) Sales by Sherritt Gordon Mines Limited	(3) Sales by Western Co-operative Fertilizers Limited	Total Sales by All Companies	(4) Total Fertilizer Consumption in Western Canada	(5) Apparent Sales of Fertilizer Outside of Western Canada
	(thousands of tons)						
1963	708.5	171.0	168.8	-	1,048.3	331.1	717.2
1964	729.1	191.0	178.2	-	1,108.3	448.4	659.9
1965	754.5	222.0	214.3	-	1,190.8	511.3	679.5
1966	965.4	240.0	303.5	150.0	1,658.9	739.8	919.1
1967	995.9	195.0	331.2	180.0	1,702.1	899.8	802.3

Note: *Total fertilizer sales in all markets served by manufacturers

Source: (1) Annual company reports
(2) Estimated by author based on sales in dollar figures as outlined in annual reports. An average of $100 per tons was used.
(3) Private correspondence with Western Co-operative Fertilizers Limited.
(4) Table 7, Chapter IV, p. 45.
(5) Dominion Bureau of Statistics data show imports of fertilizers into western Canada are negligible.

the fertilizer needs of United Grain Growers Limited and Alberta-Pacific Grain Limited. The author estimates that Sherritt Gordon Mines Limited probably supplies about 20 per cent of the western Canadian fertilizer market. The approximate relative market positions of the various manufacturers in western Canada are outlined in Table 5.

TABLE 5

The Approximate Share of the Western Canadian Fertilizer Market by Manufacturer for 1967

Manufacturer	Sales in Western Canada	Estimated Percentage of Western Canadian Market
	(thousands of tons)	
Cominco	265	29
Western Co-operative Fertilizers Limited	180	20
Sherritt Gordon Mines Limited	180	20
Imperial Oil Limited	135	15
Simplot Chemical Company Limited) Northwest Nitro-Chemicals Limited)	140	16
1967 Total Sales	900	

5: SIGNIFICANCE OF INDUSTRY TO WESTERN CANADA'S ECONOMY

Presently there are eight operational fertilizer plants in western Canada. Five of these manufacturing plants are located in

Alberta, two in British Columbia and one in Manitoba. These fertilizer plants employ approximately 2, 900 persons who have a total gross payroll of over $20 million annually.[19] According to the 1966 Census of Canada, the average number of persons per family in western Canada is 3. 8;[20] at this rate over 11, 000 persons are directly dependent on the fertilizer industry.

The fertilizer industry affects many segments of the economy of western Canada. A substantial volume of business accrues to the railways in providing cars for raw material acquisition and finished goods shipments. For example, in 1968, 1, 226, 419 tons of phosphate rock were unloaded from rail cars in western Canada.[21] At an average load of 50 tons per car this would represent 24, 528 carloads of product.

In addition to the raw materials outlined in Table 2, fertilizer plants utilize electricity, paper bags, coating agents and various chemicals. The author was unable to secure figures showing the money expended for these commodities by manufacturers in British Columbia and Manitoba. However, the five fertilizer manufacturers in Alberta alone purchase annually over $2 million worth of electri-

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[19] Private correspondence with each company.

[20] Canada, Dominion Bureau of Statistics, "Household and Families, Families by Size," 1966 Census of Canada, Catalogue No. 93-609, Table 52 (Ottawa: Queen's Printer, 1966), p. 1.

[21] Canada, Dominion Bureau of Statistics, Railway Freight Traffic, Catalogue No. 52-205, Table 15 (Ottawa: Queen's Printer, 1968), p. 90.

city, $0.5 million worth of coating agents and chemicals and approximately $3 million worth of paper bags.[22]

With five of the eight fertilizer plants located in Alberta, the influence of the fertilizer industry has been more pronounced in this province than any of the other three western provinces. At the end of 1967, accumulated expenditures for nitrogen-phosphate fertilizer plants in Alberta during the preceeding 20 years totalled approximately $150 million.[23] This investment in fertilizer plants accounted for more than 10 per cent of the total private and public investment in all manufacturing complexes in Alberta in the same time period, 1948-1968.[24]

The value of manufacturing shipments by major industrial groups in Alberta is outlined in Table 6. Sales by Sherritt Gordon Mines Limited are included in the category "Primary Metal",[25] whereas sales by the other fertilizer manufacturers are included in the category "Chemical & Chemical Products".[26] With the comple-

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[22] Letter dated Jan. 15, 1969 from D. D. Tamney, Market Research Officer, Alberta Bureau of Statistics, on the subject of raw material purchased by the fertilizer companies in Alberta.

[23] Letter dated Jan. 30, 1969 from D. D. Tamney, Market Research Officer, Alberta Bureau of Statistics, to the author on the subject of capital investments of Alberta fertilizer plants.

[24] Alberta Bureau of Statistics, <u>Alberta Industry and Resources</u>, Table 67 (Edmonton: Queen's Printer, 1968), p. 116.

[25] Tamney, dated Jan. 30, 1969.

[26] <u>Ibid</u>.

tion of the Imperial Oil Limited plant this year, the fertilizer industry in Alberta produces a range of products valued at approximately $100 million annually, making this industry the sixth manufacturing industry in the province by value of products.

The two fertilizer plants of Cominco Limited in British Columbia are both parts of integrated metallurgical complexes and

TABLE 6

Value of Manufacturing Shipments,
Alberta, 1968

Industries	Shipments ($'000)
Foods and Beverages	660,000
Petroleum Refining	153,000
Primary Metal	140,000
Chemical and Chemical Products	119,000
Non-Metallic Mineral Products	110,000
Metal Fabricating	95,000
Wood	75,000
Transportation Equipment	55,000
Paper and Allied	51,000
Printing, Publishing and Allied	51,000
Miscellaneous Manufacturing	34,000
Clothing	25,000
Electrical Products	24,000
Machinery	23,000
Furniture and Fixtures	18,000
Textile	11,000

Note: The 1968 figures are preliminary and represent "gross value" of shipments.

Source: Alberta Bureau of Statistics, Summary of General Statistics, p. 8.

therefore it is difficult to assess their affect on the provincial economy with any degree of accuracy. Since Simplot Chemical Company Limited is the only manufacturer of fertilizers in Manitoba, its impact on Manitoba's economy is limited.

In all provinces the municipalities where the fertilizer plants are located benefit from the taxes generated. These taxes include payments from individuals and the companies themselves.

CHAPTER IV

AN EVALUATION OF THE MARKETS FOR WESTERN CANADIAN-MADE FERTILIZERS

1: INTRODUCTION

The purpose of this chapter is an historical review of the fertilizer consumption patterns in the markets where western Canadian-made fertilizers are sold. Western Canadian manufacturers compete with each other in western Canada and with other fertilizer manufacturers in the United States and offshore world markets.[1] Each of these markets will be discussed in turn.

2: THE WESTERN CANADIAN MARKET

In reviewing the consumption of fertilizers in Canada, it is convenient to divide the country into the western Canadian and eastern Canadian markets separated by the Ontario-Manitoba Border. These areas require different fertilizers and are supplied by different companies.[2] Since the fertilizer manufacturers of western

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[1] Offshore markets refer to all foreign markets except the United States.

[2] Brown, "Agricultural Phosphates," p. 311.

Canada do not serve the eastern Canadian market, the eastern market and its suppliers are not considered in this thesis.

Under the grain quota system, farmers in western Canada have little impetus to use substantial amounts of fertilizer on their large expanses of land if grain quotas are easily filled.[3] Prior to the late 1950's grain quotas were being readily filled using only small amounts of fertilizer. However, in the late 1950's improvements in wheat exports to mainland China, the U.S.S.R. and the United Kingdom resulted in increased quotas and this induced a mood of optimism and a willingness by the prairie farmer to use fertilizer. As outlined in Figure 3, between 1956 and 1968 consumption of fertilizers in western Canada increased rapidly. A perusal of Figure 3 also reveals that almost all the increased consumption of fertilizers in western Canada is attributable to fertilizer materials rather than mixtures. In 1954 fertilizer materials accounted for approximately 84 per cent of all fertilizer sold, while by 1968 this figure had increased to 96 per cent of the total.[4] This reliance on fertilizer materials is understandable since the soils of the Canadian prairies are generally adequately supplied naturally with potash.[5]

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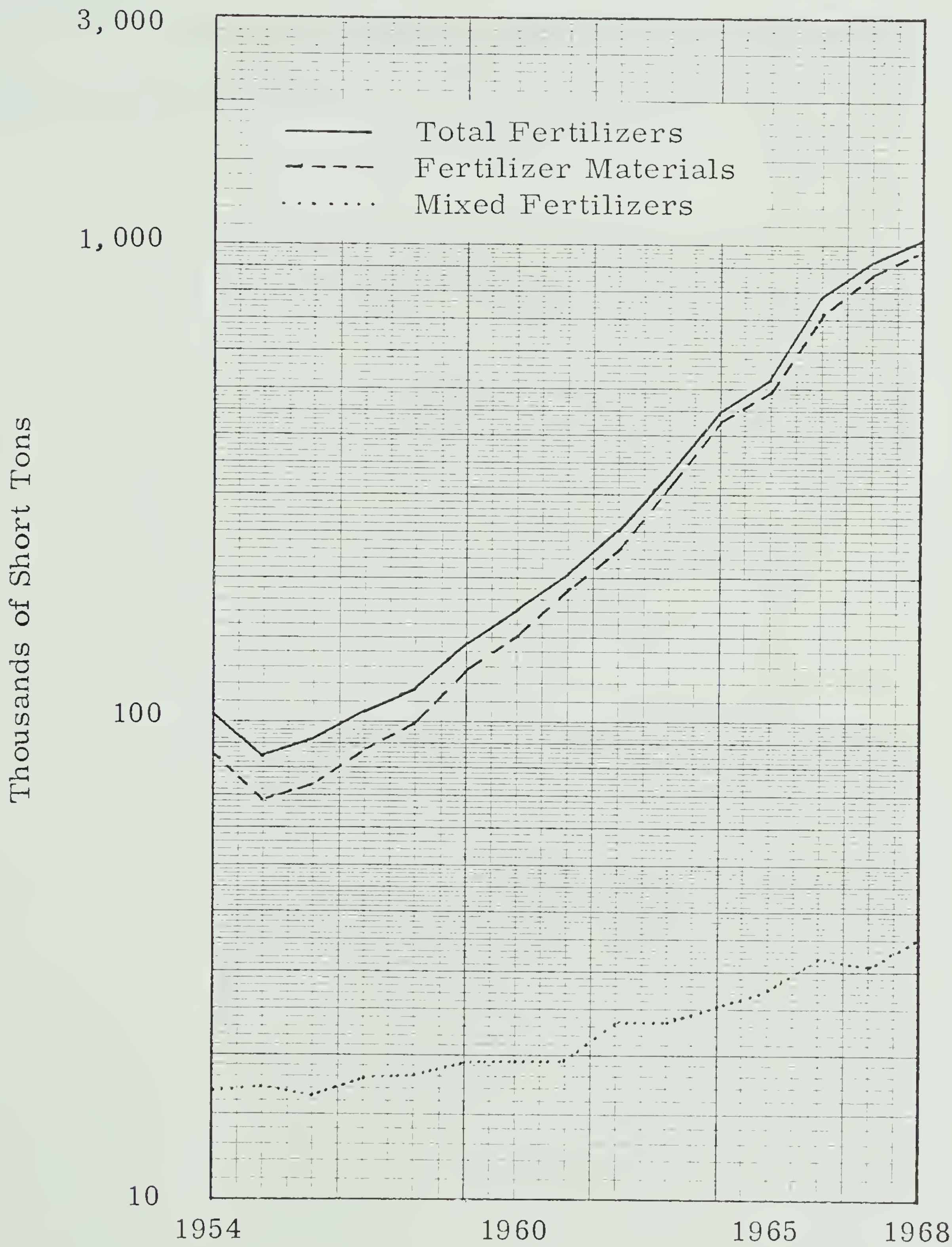
[3] C. F. Bentley, "Fertilizer Usage in the Prairie Provinces 1965-1975" (speech presented to the Canadian Fertilizer Association, Edmonton, Alberta, August, 1965), p. 4.

[4] Appendix C, Table C-1.

[5] "Phosphates," Chemical Week, October 24, 1964, p. 130.

FIGURE 3

Total Sales of Fertilizer Materials, Mixed Fertilizers and Total Fertilizers in Western Canada, 1954-1968

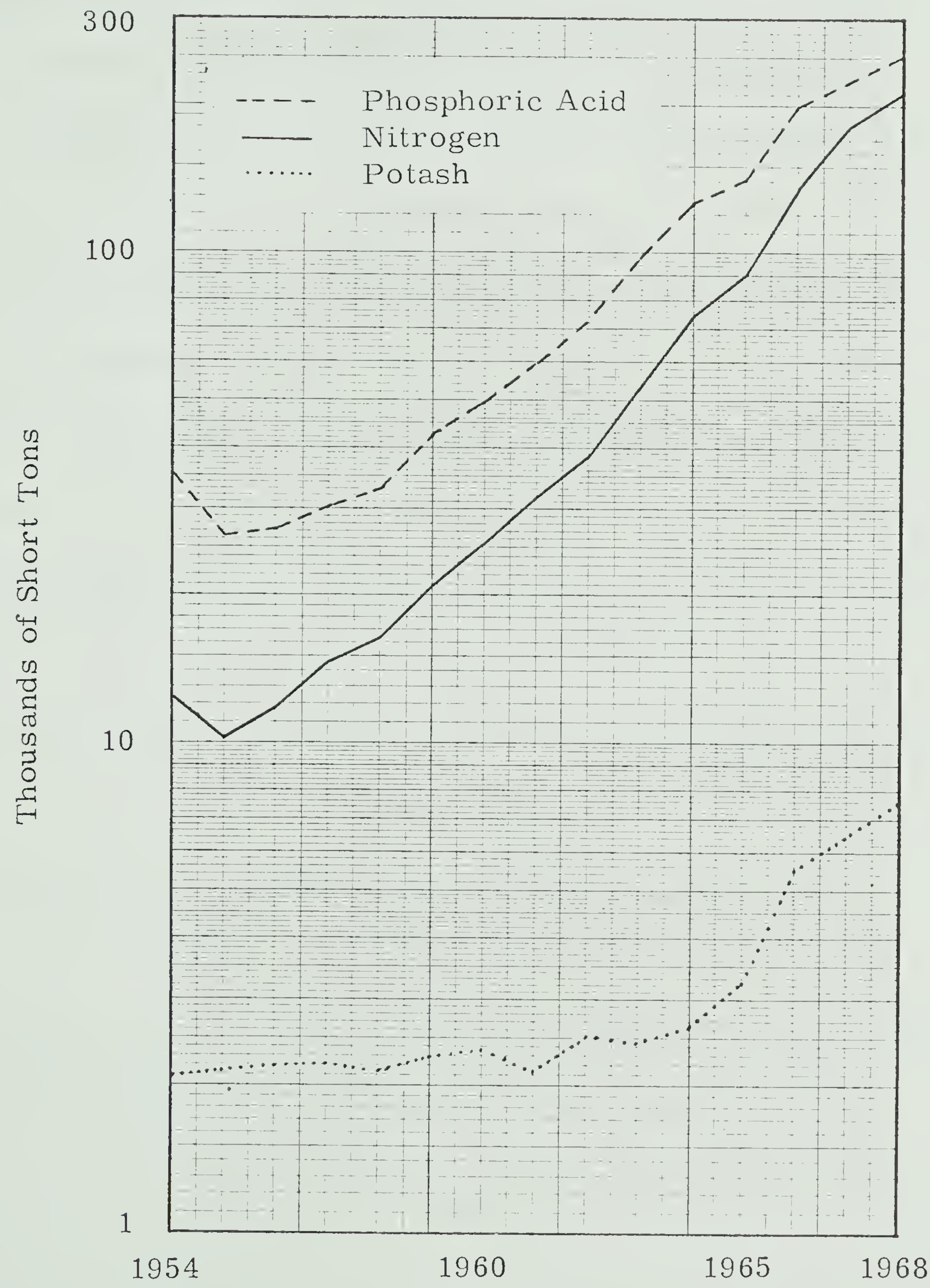


Source: Appendix C, Table C-1.

Figure 4 shows the dramatic increase of the nitrogen and phosphoric acid content of the various fertilizers used in western Canada. Annual consumption of nitrogen and phosphoric acid increased 1,614 per cent and 633 per cent respectively between 1954 and 1968, whereas annual potash consumption increased 277 per cent in the same period.

FIGURE 4

Total Nitrogen, Phosphoric Acid and Potash Contained in Fertilizers Sold in Western Canada, 1954-1968



Source: Appendix C, Table C-2.

Table 7 outlines the total sales of some selected fertilizer materials in western Canada. Ammonium phosphate (11-48-0) continues to be the most popular fertilizer on the prairies; however, ammonium phosphate (16-20-0) which contains sulphur, and some of the newer forms of ammonium phosphate (16-48-0), (18-46-0) and (11-55-0) are showing significant consumption increases. Also outlined in Table 7 is the fact that in 1968 for the first time since 1955, the annual consumption of (11-48-0) showed a slight decline over the previous years' annual consumption; the increasing popularity of newer grades of ammonium phosphates appears to be the reason for the slight decline in sales of (11-48-0) and also (16-20-0). Straight ammonium nitrate is still being used in an increasing volume in western Canada, even though the newer ammonium nitrate-phosphates (23-23-0) and (27-14-0) have captured over one-fifth of the market. The use of ammonium sulphate in the last few years has levelled off, probably because it does not contain phosphorus, a needed plant nutrient for prairie soils. Table 7 shows that the sales of urea have increased from less than 100 tons in 1960 to over 32,000 tons in 1968; the high nitrogen content of this fertilizer, together with its excellent handling

qualities, make it popular.[6]

In the last ten years, consumption of fertilizers in western Canada has increased at an average rate exceeding 12 per cent annually (Table 8). As outlined in Table 8, the three prairie provinces accounted for approximately 95 per cent of the total fertilizer sales in western Canada in 1968, and the trend indicates that this percentage will increase in the future.

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[6] Appendix C, Table C-12 to C-18, outline the sales of the fertilizers shown in Table 7, by province and for western Canada in total; yearly percentage increases or decreases in sales for each fertilizer material in each province are computed. Sales of anhydrous ammonia, muriate of potash, normal superphosphate, triple superphosphate and calcium cyanamide, by province in western Canada, are outlined in Appendix C, Tables C-19 to C-23. Sales of these above-mentioned fertilizers amounted to nearly 17,000 tons in 1968, or less than 2 per cent of fertilizer sales in western Canada.

TABLE 7

Total Sales of Some Selected Fertilizer Materials
in Western Canada, 1954-1968

Year	Fertilizer Material						
	Ammonium Nitrate	Ammonium Nitrate Phosphate	Ammonium Phosphate (11-48-0)	Ammonium Phosphate (16-20-0)	Ammonium Phosphate Other Grades[1]	Urea	Ammonium Sulphate
	(thousands of tons)						
1954	4.7		61.8	14.2			3.1
1955	5.5		43.9	10.8			3.1
1956	6.0		44.1	14.6			4.7
1957	8.4		47.8	17.8			3.5
1958	9.8		52.9	21.2			4.1
1959	13.1		68.2	28.7			4.9
1960	17.5		78.7	33.6		0.1	5.9
1961	21.6		94.2	43.2		0.2	9.2
1962	23.4	18.2	114.7	55.0		0.3	9.8
1963	34.3	30.9	149.9	71.9	2.7	1.0	12.9
1964	48.9	50.5	192.8	97.6	2.3	3.9	19.4
1965	56.9	72.1	215.4	102.6	2.2	4.5	18.9
1966	92.2	138.4	292.4	123.0	1.5	11.9	23.6
1967	126.7	229.9	303.6	95.2	14.4	26.1	27.8
1968	145.8	245.5	298.9	76.5	71.5	32.1	31.5

Note: 1 The "other grades" of ammonium phosphates include 16-48-0, 11-55-0 and 18-46-0 in addition to other grades not specified by the Dominion Bureau of Statistics.

Source: Appendix C, Tables C-12 to C-18

TABLE 8

Total Sales of Fertilizers in Western Canada by Province,
Years Ended June 30, 1954-1968

Year	Manitoba	Saskatchewan	Alberta	British Columbia	Total Western Canada	Annual Percentage Increase Western Canada
	(thousands of tons)					%
1954	22.1	24.6	28.4	30.4	105.5	
1955	14.6	15.9	24.3	30.8	85.6	-18.9
1956	15.5	18.0	29.3	29.7	92.5	8.1
1957	15.7	20.8	38.3	30.0	104.8	14.3
1958	16.3	21.4	47.9	30.1	115.7	10.4
1959	21.1	27.6	65.2	32.7	146.6	26.7
1960	22.5	34.9	79.9	33.6	170.9	16.6
1961	29.9	39.4	104.1	33.2	206.6	20.9
1962	35.1	47.9	126.9	43.3	253.2	22.5
1963	47.1	72.3	170.4	43.3	333.1	31.2
1964	59.8	119.3	224.1	45.0	448.2	34.5
1965	74.4	137.2	252.2	47.4	511.2	14.1
1966	153.4	214.7	316.1	55.5	739.7	44.7
1967	181.1	265.8	398.9	53.8	899.6	21.6
1968	242.3	268.2	442.9	54.9	1,008.3	12.1

Note: "Fertilizers" includes Fertilizer Materials and Mixed Fertilizers.

Source: Appendix C, Tables C-6 and C-7.

3: THE WESTERN UNITED STATES MARKET

Fertilizers manufactured by companies in western Canada are sold throughout the western United States including all of California, Arizona, part of New Mexico, and most of Colorado, Nebraska, Iowa and Wisconsin; in total, sixteen states are partly supplied by western Canadian fertilizer manufacturers.[7] Map 1 shows the approximate geographic extent of this market, and for simplicity, this geographic area will hereafter be referred to as the western United States market.

An indication of the relative size of the western United States market in comparison with the western Canadian market is evident from an examination of Table 9. Western Canada as a whole consumed a total of 1,008,300 tons of fertilizers in 1968, or approximately 10 per cent of the total fertilizer consumption in the western United States, which totalled 10,371.2 thousand tons that same year. Although the western United States market and the western Canadian market differ significantly in size they are similar in their dependence on nitrogen and specific fertilizer materials.[8]

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[7] Wilkinson, 'The Effect of Natural Gas," p. 171.

[8] Appendix D, Tables D-1 to D-16, show the consumption by state (in the western United States) of mixed fertilizers, primary materials, secondary nutrients, total fertilizers, and the nitrogen, phosphorus and potash content of all fertilizer consumed for the period 1954 to 1968.

MAP 1

The Western United States Market for Western Canadian-Made Fertilizers

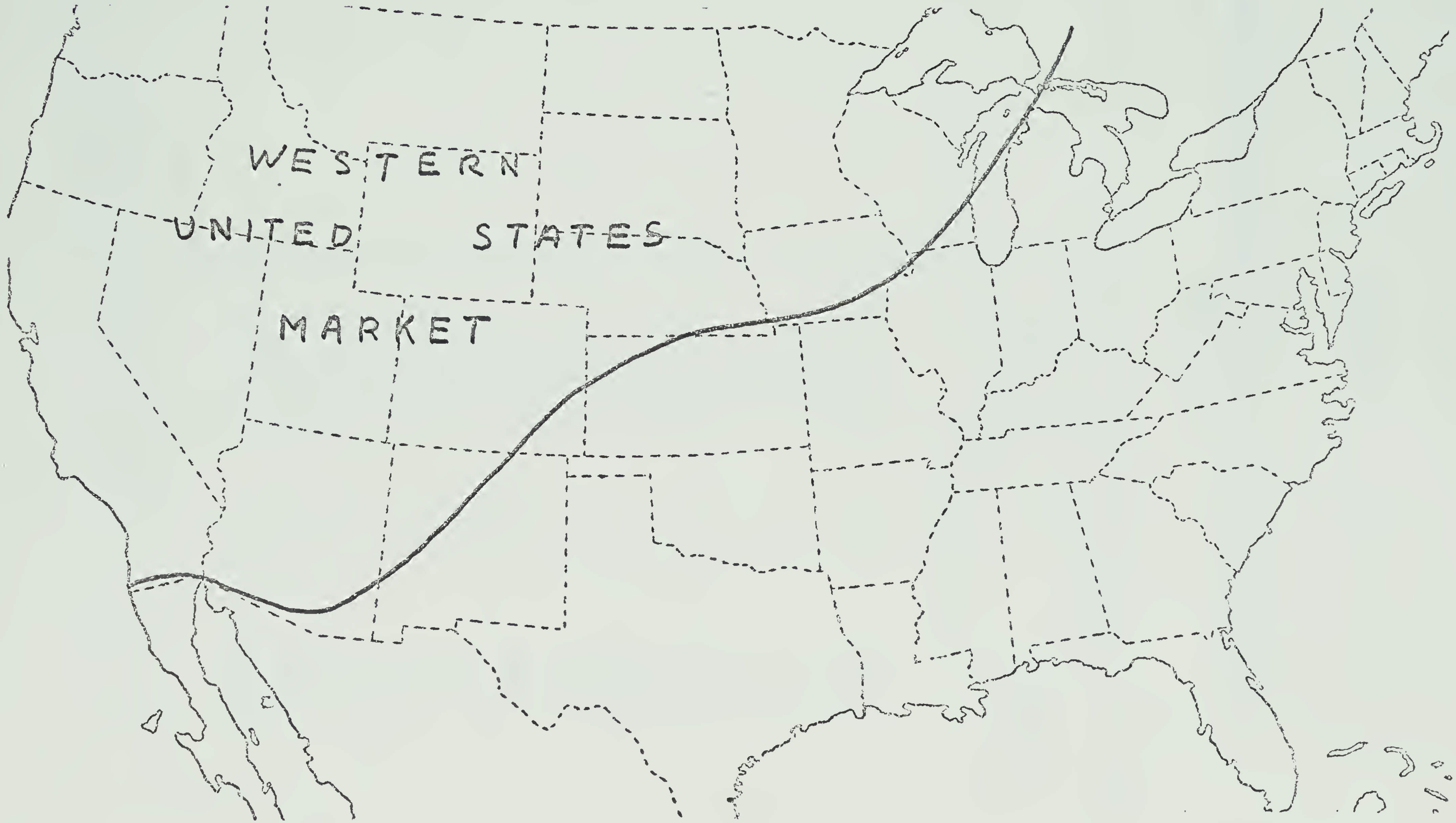

TABLE 9

A Comparison of Total Fertilizers Sold in the Western United States Market and the Western Canada Market, 1954-1968

Year	Total Fertilizer Sales	
	Western United States (1)	Western Canada (2)
	(thousands of tons)	
1954	3,403.8	105.5
1955	3,599.5	85.6
1956	3,383.8	92.5
1957	3,724.3	104.8
1958	4,102.5	115.7
1959	4,670.6	146.6
1960	4,692.4	170.9
1961	5,190.6	206.6
1962	5,353.9	253.2
1963	5,939.4	333.1
1964	6,637.9	448.2
1965	7,194.1	511.2
1966	8,004.0	739.7
1967	9,489.9	899.6
1968	10,371.2	1,008.3

Source: 1. Appendix D, Aggregation of Tables D-1 to D-16.

2. Table 8.

Fertilizers enter the United States duty-free, and therefore fertilizer manufacturers in western Canada are able to compete in the United States with American manufacturers on equal competitive terms. Products supplied to the western United States market by western Canadian fertilizer plants include ammonium sulphate, ammonium nitrate, urea and combinations of nitrogen and phosphorus (ammoniated phosphates). In addition to the above fertilizers, nitrogen solutions and anhydrous and aqua ammonia are supplied for direct application to the soil.[9] Tables D-17 to D-48 (Appendix D) show the respective growth of all the above-mentioned fertilizers in the western United States for the period 1954 to 1968.

In 1967, exports of fertilizers to the United States from Canada amounted to over $65 million. Of this total approximately two-thirds, or $43 million worth of fertilizers, were cleared for export through customs ports in western Canada for sales in the western United States.[10]

The use of Canadian export statistics is hampered because the exports of specific fertilizers are only stated in dollars and not tons; therefore, factual comparisons of Canadian domestic sales of

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[9] Wilkinson, "The Effect of Natural Gas," p. 171.

[10] Canada, Dominion Bureau of Statistics, <u>Exports by Commodities</u>, Monthly publication No. 65-004 (Ottawa: Queen's Printer, 1967).

certain fertilizers and exports are difficult. However, the United States Department of Agriculture reported imports from Canada in 1967 of approximately 1,020,000 tons of the specific fertilizers outlined in Table 10.[11] Therefore, fertilizer manufacturers in western Canada exported about 680,000 tons of various fertilizers to the western United States market in 1967. Although these exports represent only seven per cent of the western United States market they are significant to western Canadian fertilizer manufacturers because they represent over 20 per cent of their total productive capacity.[12] These exports are also equivalent to 75 per cent of total fertilizer sales in western Canada.[13] Western Canadian fertilizer manufacturers are therefore producing products needed by farmers in the western United States; these manufacturers are able to supply this market as a result of two conditions, no duty rates and a close proximity to market.

Unfortunately, the 1968 statistics of exports by province of clearance[14] in western Canada are not available at this time. If western Canada continues to account for two-thirds or 66 per

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[11] U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, The Fertilizer Supply (Washington, D.C.: Government Printing Office, 1968), p. 13.

[12] Table 3, Chapter III, p. 35.

[13] Table 8, Chapter IV, p. 50.

[14] Province of clearance refers to the province where the fertilizer cleared customs to enter the United States.

cent of some specific fertilizer exports to the United States, then the 1968 export figures from western Canada will approximate the same value and tonnage as the 1967 exports.

4: THE WORLD MARKET

Although the United States is by far the largest export market for Canadian-made fertilizers, it is not the only export market (Table 11). In the five year period 1964 to 1968, fertilizer manufacturers of Canada exported approximately $27 million worth of fertilizers to the United Kingdom, Pakistan, India, Japan, Australia, New Zealand, Mexico, Netherlands, Peru, Tunisia, Israel, Bermuda, France, Costa Rica, and other countries around the world.[15] In the years 1964 to 1967, western Canadian fertilizer manufacturers exported offshore, through British Columbia ports, nearly $8 million worth of fertilizers (Table 12). Exports of fertilizers from western Canada to Pakistan and India are made under the Canadian government's Colombo Plan, whereas most other exports are made under world market conditions.

The 1967 fertilizer exports to the United States averaged $63 per ton.[16] Using this same per ton value the $2.4 million worth of fertilizers exported offshore in 1967 amounted to just

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[15] Appendix E, Tables E-1 to E-4

[16] Exports of 680,000 tons valued at $43 million, pp. 55-56.

TABLE 10

The Value of Selected Fertilizer Exports to the United States
Through Custom Ports in Western Canada
and Canada in Total, 1964-1968

	Western Canada	Total Canada
	(thousands of dollars)	
Ammonium Nitrate		
1964	4,674.3	10,319.5
1965	3,893.3	10,181.9
1966	1,907.2	8,980.0
1967	1,651.6	9,003.0
1968	n/a	11,097.0
Urea and Nitrogen Solutions		
1964	5,218.2	15,304.7
1965	4,975.7	14,749.0
1966	5,506.6	13,824.0
1967	6,527.9	13,581.0
1968	n/a	14,008.0
Nitrogen-Phosphate Fertilizer, N.E.S.		
1964	10,092.8	10,243.6
1965	19,206.9	19,457.0
1966	22,404.7	22,782.0
1967	25,273.0	26,596.0
1968	n/a	24,397.0
Ammonium Sulphate		
1964	4,064.3	4,978.7
1965	5,637.6	6,395.3
1966	5,651.1	5,897.0
1967	6,626.4	6,707.0
1968	n/a	5,006.0
Prepared Fertilizer Mixtures		
1964	867.0	3,329.3
1965	192.4	3,756.1
1966	1,834.8	6,045.0

TABLE 10 Continued

	Western Canada	Total Canada
	(thousands of dollars)	
1967	1,296.4	5,781:0
1968	n/a	5,253.0
Fertilizers and Fertilizer Materials N.E.S.		
1964	(1)	(1)
1965	(1)	(1)
1966	1,158.5	3,100.0
1967	1,439.3	3,363.0
1968	n/a	2,661.0

Note: (1) Prior to 1966 muriate of potash was included in this category.
N.E.S. - not elsewhere specified in export statistics
n/a - not available at this time

Source: 1. Canada, Dominion Bureau of Statistics, Exports by Commodities, Monthly Publication No. 65-004 (Ottawa: Queen's Printer, 1964-1968).

2. Special reports from Dominion Bureau of Statistics

over 39,000 tons of products. Offshore exports therefore are the equivalent of less than five per cent of the domestic sales in western Canada.[17]

Figure 5 depicts the world's consumption (excluding mainland China) of fertilizers since 1945; as outlined, world consumption of all fertilizers expanded rapidly after the Second World War. The total increase in the last reported five year period, 1960 to 1965, amounted to 48 per cent. World consumption of nitrogen exceeded phosphoric acid in terms of plant nutrient content for the first time in 1960, whereas the share of potash in the total world's consumption of all fertilizer is remaining about 28 per cent.

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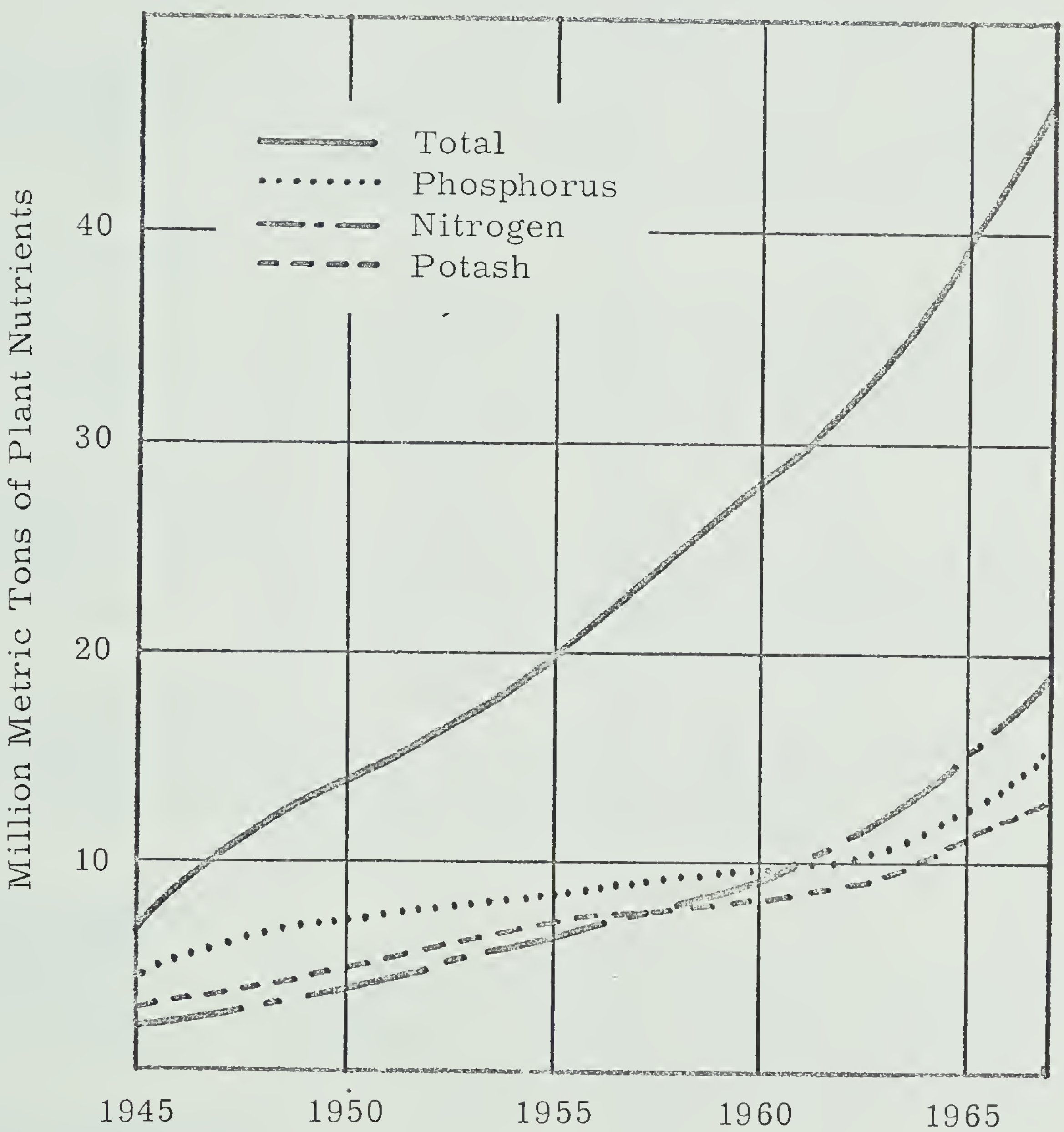
[17] Table 8, Chapter IV, p. 50.

FIGURE 5

World Plant Nutrient Consumption



Source: Harre, Fertilizer Trends, p. 75.

TABLE 11

Exports of Fertilizer to the United States in Comparison to All Other Countries of the World, 1964-1968

Type of Fertilizer and Area of Import	Value of Exports Per Year				
	1964	1965	1966	1967	1968
	(thousands of dollars)				
Ammonium Nitrate					
United States	10,319.5	10,181.9	8,980.0	9,003.0	11,097.0
Other Countries	692.1	14.6	23.0	653.0	1,102.0
Total	11,011.6	10,196.5	9,003.0	9,656.0	12,199.0
Urea and Nitrogen Solutions					
United States	15,304.7	14,749.0	13,824.0	13,581.0	14,008.0
Other Countries	214.3	147.3	17.0	2,214.0	4,759.0
Total	15,159.0	14,896.3	13,841.0	15,795.0	18,767.0
Nitrogen Phosphate Fertilizers					
United States	10,243.6	19,457.0	22,782.0	26,596.0	24,397.0
Other Countries	12.1	0.0	7.0	0.0	1,368.0
Total	10,255.7	19,457.0	22,789.0	26,596.0	25,765.0
Ammonium Sulphate					
United States	4,978.7	6,395.3	5,897.0	6,707.0	5,006.0
Other Countries	1,078.7	3,345.5	1,386.0	34.0	2,816.0
Total	6,057.4	9,740.8	7,283.0	6,741.0	7,822.0
Prepared Fertilizer Mixtures					
United States	9,380.2	3,756.1	6,045.0	5,781.0	5,253.0
Other Countries	6,050.9	29.0	42.0	102.0	72.0
Total	15,431.1	3,785.1	6,087.0	5,883.0	5,325.0
Fertilizer and Fertilizer Materials N.E.S					
United States	(1)	(1)	3,100.0	3,363.0	2,661.0
Other Countries	(1)	(1)	40.0	391.0	58.0
Total	(1)	(1)	3,140.0	3,754.0	2,719.0

Note: (1) Prior to 1966, muriate of potash was included in this category
N.E.S. - not elsewhere specified in export statistics

Source: Appendix E, Tables E-1 to E-4

TABLE 12

The Value of Offshore Exports of Fertilizers Cleared
Through British Columbia Customs Ports
By Importing Country, 1964-1967

Type of Fertilizer and Importing Country	Year and Value			
	1964	1965	1966	1967
	(thousands of dollars)			
Urea and Nitrogen Solutions				
India				1,386.0
Australia		8.2		
United Kingdom	210.0			
Nitrogen Phosphate Fertilizers, N.E.S.				
Malaysia			7.1	
Ammonium Sulphate				
Australia	390.0	843.8	903.8	34.0
India		1,286.2	1,482.2	
Pakistan	688.7	330.0		
Philippines		85.5		
Fertilizers and Fertilizer Materials N.E.S.				
Japan	(1)	(1)	64.2	
Mexico			11.0	30.2
United Kingdom		(1)		
France				44.0
Philippines	(1)	(1)		
Italy			0.1	0.4
Taiwan	(1)	(1)		
Netherlands		(1)		0.3
New Zealand	(1)	(1)		
Spain				0.9
Cyprus				0.1
Israel	(1)			26.1
Republic of South Africa			0.1	1.0
Hong Kong				0.1
Australia		(1)	1.8	6.9

TABLE 12 Continued

Type of Fertilizer and Importing Country	Year and Value			
	1964	1965	1966	1967
	(thousands of dollars)			
Peru				14.4
Costa Rica		(1)		0.9
Brazil	(1)	(1)		
Guatemala		(1)		
Total Fertilizers	1,288.7	2,553.7	2,470.3	1,545.3

Note: (1) Prior to 1966, muriate of potash was included in this category.
N. E. S. - means not specified elsewhere

Source: Special reports from Dominion Bureau of Statistics

CHAPTER V

THE MARKETING OF FERTILIZERS BY THE MANUFACTURERS IN WESTERN CANADA

1: INTRODUCTION

The various marketing and distribution systems used by fertilizer manufacturers to market their products in western Canada, the western United States and offshore world markets will be considered first followed by an analysis of the pricing practices employed in each of these areas. A review of product competition and the promotional techniques employed by manufacturers conclude the chapter.

2: DISTRIBUTION AND MARKETING SYSTEMS

Fertilizer markets are characterized by two factors: firstly, a large number of users (farmers) who buy from a relatively small number of sellers; secondly, a heavy demand season which only lasts for about three months. The ability to deliver fertilizer at the time and in the form demanded by farmers is a critical problem for manufacturers. Large quantities of fertilizer must be pre-positioned in consuming areas.

Fertilizer is a high bulk commodity with a low unit value. Therefore transportation, storage and distribution costs account for a large part of the final price. Sauchelli states that transportation costs alone account for 30 to 40 per cent of the delivered price of fertilizer.[1] The marketing and distribution systems employed in the various markets served by western Canadian fertilizer manufacturers will now be considered in detail.

(a) Western Canada Market

Prior to the establishment of the Northwest Nitro-Chemicals' plant at Medicine Hat, Alberta, in 1956, Cominco Limited was a monopoly supplier for farmers in Alberta, Saskatchewan and Manitoba. Cominco distributed its "Elephant" brand fertilizer products through a network of agricultural machinery and equipment dealers, feed and seed stores, farm oil bulk stations, and other individuals interested in distributing fertilizers; up to this time Cominco did not supply the "line elevator companies".[2] In 1956, Northwest Nitro-Chemicals began manufacturing fertilizers and obtained an entry into the market by appointing a number of the line elevator companies (Pioneer, National, Federal, Alberta-

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[1] V. Sauchelli, "Ag Chem Views and News," Agricultural Chemicals, May, 1969, p. 48.

[2] Line elevator companies are private shippers of grain from prairie towns. In addition to line elevator companies, each province has its own "Co-operative Pool Elevators", Alberta, Saskatchewan, Manitoba Wheat Pools. United Grain Growers is another separate co-operative from the pool elevators.

Pacific) and United Grain Growers as distributors. To combat Northwest's competition, Cominco appointed some other line elevator companies (McCabe, Patterson, Searle) as distributors, and also commenced supplying fertilizer to the Inter-Provincial Co-operatives Limited for private brand packaging under the Co-op "Indian" brand name. Inter-Provincial Co-operatives distributed fertilizer to Federated Co-operatives for resale through the many co-op retail stores in towns all over the three prairie provinces; Inter-Provincial Co-operatives also channeled some fertilizer to the Alberta and Saskatchewan Wheat Pools for resale from their elevators.[3]

Since 1956, Sherritt Gordon Mines Limited and Western Co-operative Fertilizers Limited have established plants in Alberta, and Border Fertilizer Limited and Simplot Chemical Company Limited commenced manufacturing fertilizers in Manitoba. With the entry of these various companies, the distribution arrangements which Cominco and Northwest Nitro had originally established in 1956 have changed significantly. Imperial Oil Limited's entry into the market as a manufacturer in 1969 resulted in further changes. The distribution system established by each manufacturer in western Canada, for the fertilizer year ending June 30th, 1969,

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[3] Personal interview with Mr. T. C. McBeth, Western Manager, Cominco Limited, Calgary, on the subject of Cominco Limited, Dec. 28, 1966.

will now be outlined.[4]

Although Cominco has lost its position as a supplier to the Co-operatives, because of Western Co-operatives' plant at Calgary, it still supplies the fertilizer needs of two line elevator companies, McCabe and Patterson. In addition to these elevator companies, Cominco supplies fertilizer for approximately 500 independent dealers in the three prairie provinces. Cominco had been supplying the fertilizer needs of Imperial Oil Limited; however, this five-year contract terminated in June of 1969, upon completion of Imperial Oil's plant at Redwater. In British Columbia Cominco distributes products to four companies, Green Valley Chemical Fertilizer Company, Buckerfield Limited, Globe Fertilizer Company Limited and Evergreen Chemical and Fertilizer Company Limited.[5]

Imperial Oil Limited has been marketing fertilizer through its own petroleum agents in the three prairie provinces since 1964. Presently Imperial has 522 of these agents handling its "Engro" brand fertilizers in the three prairie provinces.[6]

Northwest Nitro-Chemicals presently markets its fertilizers through the National and Pioneer Grain Companies in western

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[4]In the fertilizer industry the year-end is June 30th of each year.

[5]Personal interview with Mr. T. C. McBeth, Dec. 28, 1966.

[6]Imperial Oil Limited, "Plans for Engro," p. 2.

Canada. In addition, Northwest provides Shell Canada Limited with its fertilizer requirements and also sells fertilizer to several independent dealers in Alberta.[7]

For the current fertilizer year, Sherritt Gordon is supplying all the fertilizer requirements of Federal Grain (which now includes Searle Grain and Alberta-Pacific Grain Company) and the United Grain Growers. These arrangements give Sherritt Gordon over 1,000 marketing outlets for its fertilizers in the three prairie provinces.[8]

Simplot Chemical Company Limited only began manufacturing fertilizers in Manitoba in 1967. This current year, Simplot is supplying independent dealers in Manitoba and Saskatchewan, and the Manitoba Wheat Pool, previously supplied by Border Fertilizer Limited which ceased operations in 1968.[9]

Western Co-operative Fertilizers Limited is the corporate identity of a three-way partnership of the Alberta and Saskatchewan Wheat Pools, and Federated Co-operatives Limited; therefore, Western Co-op supplies the fertilizer needs of these three partners.

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[7] Letter dated Feb. 14, 1969, from D. D. Tamney, Marketing Research Officer, Alberta Bureau of Statistics, to the author on the subject of fertilizer companies and their distributors.

[8] Letter from M. A. Schoening, Sherritt Gordon Mines Limited, dated Dec. 3, 1968.

[9] Letter from D. D. Tamney, Alberta Bureau of Statistics, dated Feb. 14, 1969.

Fertilizer needs of the partners have been such that Western Co-operatives has not been faced with excess inventories needing disposition to other customers.[10]

The channels of distribution between the fertilizer manufacturer and the farmer in western Canada usually only include a dealer; fertilizer manufacturers sell their products to a variety of distributors or dealers, who in turn sell directly to the farmer. A main distributor (a line elevator company, dealer, or similar agent) may sell partly through sub-distributors, who may be local store-owners, or other farm suppliers. Dealers have a functional place in the distribution channel because they warehouse large quantities of bulk and bagged fertilizers and then break down these quantities, depending on the individual needs of any farmer. All manufacturers have their own off-plant storage sites, and dealers may be supplied from these warehouses or directly from the manufacturers on net 30 day terms and sell to farmers on the same basis with regular bank interest thereafter. However, credit is a major problem for distributors who often find they must extend terms to six months or longer.[11]

One of the biggest problems facing all fertilizer manufac-

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[10] Western Co-operatives Fertilizers Limited, Welcome to Co-op Fertilizer Calgary Plant, p. 1.

[11] Personal interview with Mr. K. Stiles, Economist, Sherritt Gordon Mines Limited, on the subject of marketing fertilizers, Dec. 2, 1966.

turers is the seasonability of demand. Despite the efforts of manufacturers to promote fall deliveries by price discounts, two-thirds of all fertilizer consumed is ordered in a three-month period (March-May) in the spring. Distribution and warehousing problems to ensure farm delivery of fertilizers during this peak demand period necessitate inventories in a great many locations. An official of Cominco gave the example that as of March 1st, Cominco would have a total inventory of 300,000 tons of fertilizers spread over 1,000 locations in Canada and the United States.[12] Imperial Oil Limited recently invested $7 million on 415 fertilizer warehouses in the three prairie provinces.[13] All manufacturers have warehouses both at their respective plant sites and in various farm areas of western Canada.

(b) <u>Western United States Market</u>

With the exception of Western Co-operative Fertilizers Limited, all fertilizer manufacturers in western Canada market a portion of their annual output in the western United States. Cominco Limited developed its United States fertilizer market in the 1930's, and export sales to the western United States still account for 60 per cent of Cominco's total annual production.[14]

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[12] Wilkinson, "The Effect of Natural Gas," p. 172.

[13] "Imperial Shows Muscle in Fertilizer Market," Alberta Business Journal, January-February, 1969, p. 44.

[14] Cominco Annual Report 1967, p. 3.

Balfour-Guthrie Company Limited was the United States sales agent for Cominco until January, 1964, when Cominco American Inc. (a wholly-owned subsidiary of Cominco) assumed the sales task.[15] With its head office at Spokane, Washington, the Cominco American plant includes a 50,000 tons per day fertilizer storage plant, which includes liquid fertilizer conversion and storage facilities; Cominco ships fertilizer liquids from Trail and Calgary to the Spokane plant.[16] Early in 1966, Cominco American Inc. opened a 200,000 ton per year fertilizer plant at Beatrice, Nebraska, producing ammonium nitrate and a range of liquid fertilizers. Presently, ammonia for this plant is being purchased from Phillips Petroleum Corporation; however, in 1967 Cominco American Inc. obtained a 50 per cent interest in Hill Chemicals Inc., which is constructing a 1,000 ton per day ammonia plant at Broger, Texas. A pipeline will be constructed by Hill Chemicals to central Iowa and the Beatrice plant will eventually receive feedstock from this pipeline. Cominco American Inc. also has an interest in several subsidiary companies engaged chiefly in the distribution of fertilizers. Sales of fertilizers in 1967 by Cominco American Inc. amounted to $42.7 million in United States funds.[17]

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[15] "Cominco Comes Out of the Hills," p. 57.

[16] Cominco Story, p. 6.

[17] Cominco Annual Report 1967, p. 4.

Prior to 1960, Harrisons & Crossfields Limited handled the sales of Northwest Nitro-Chemicals Limited's fertilizers in the western United States. However, in 1960 Northwest Nitro-Chemicals Limited established a wholly owned subsidiary, Northwest Nitro-Chemicals Sales Limited, with head offices at Minneapolis, Minnesota, to market Northwest brand fertilizers in the United States.[18]

Sherritt Gordon Mines Limited used the service of Harrisons & Crossfields Limited to gain an entry into the Western United States market after the latter company's contract was terminated by Northwest Nitro-Chemicals Limited in 1960. Sherritt Gordon undertook its own marketing of fertilizers in the United States in 1968 by the establishment of a wholly-owned subsidiary, Sherritt Fertilizers Inc., with head offices in Portland, Oregon.[19]

Simplot Chemical Company Limited markets its fertilizers in the United States through the distribution network of its parent company, J. R. Simplot Company, which has 70 sales outlets from the Pacific to the Mississippi River. Simplot's sales were estimated to be $65 million in 1967, which means this company

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[18] Northwest Nitro-Chemicals Limited, Northwest Nitro-Chemicals Limited (Medicine Hat, Alberta: Northwest Nitro-Chemicals Limited, n.d.), p. 2.

[19] Sherritt Gordon Mines Limited, Sherritt Gordon Mines Limited Quarterly Report to Shareholders (Toronto: Sherritt Gordon Mines Limited, 1968), p. 1.

has captured about 15 per cent of the western United States fertilizer market.[20]

Until recently, the typical distribution pattern (for mixed fertilizers) in the western United States market was from the primary fertilizer materials manufacturer to wholesale distributors and mixers, to retail outlets or local dealers, and finally to the farmer. However, the sustained growth of the demand for fertilizers has resulted in a streamlining of this distribution system and the elimination of wholesale distributors and mixers, as manufacturers start to conduct business directly with dealers. Distribution costs are lowered and dealers are better equipped to handle the specific requirements of a farmer under the new system where dealers have direct contact with manufacturers.[21]

(c) Offshore World Markets

In general, only two fertilizer manufacturers in western Canada, Cominco Limited and Sherritt Gordon Mines Limited, sell their fertilizers in offshore world markets; both these companies have world-wide marketing arrangements for the distribution of their respective metal products, and therefore each company is well acquainted with international marketing techniques. Cominco Limited and Sherritt Gordon both have appointed dealers

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[20] Murphy, "Jack Simplot," p. 166.

[21] Thomas O'Hanlon, "All That Fertilizer and No Place to Grow," Fortune, June 1, 1968, p. 92.

in various parts of the world to market their fertilizer products.

Northwest Nitro-Chemicals Limited and Simplot Chemical Company Limited, being wholly-owned subsidiaries of United States firms, look to the western United States markets for their export sales. Imperial Oil Limited has indicated it intends to export fertilizers from its Alberta plant; however, no further details regarding the proposed destination of these exports are available at this time. All fertilizer companies are given the opportunity, by the Canadian government, to tender bids for the sale of fertilizers to India and Pakistan under the Colombo Plan agreements.

3: PRICING TECHNIQUES

In setting the prices for a product a marketing manager must consider existing practices on markups, discounts, terms of sale, the nature of competition and legal restrictions in his target market. The pricing practices employed in the various markets served by western Canadian manufacturers will now be considered.

a. Western Canada Market

The western Canadian fertilizer market exemplifies the characteristics which Kaysen outlines as typical of markets

employing a basing point pricing system.[22] Each of these characteristics will be considered in the context of the western Canadian situation.

Products are standardized allowing for substitution. The specific fertilizers produced by various manufacturers are identical and are required to be so by law. Ammonium phosphate (11-48-0) is the same product from all manufacturers. Therefore, as Kaysen states, "in an equilibrium situation the price charged by two producers at any given point must be the same".[23]

Products are low in value per unit of weight. Fertilizers are low value commodities and as previously stated transportation may account for 30 to 40 per cent of the final price. Spatial differentiation of the products, delivered to the consumer therefore forms an essential element in the system.[24]

The capital investment in a manufacturing plant is large. Fertilizer plants are constructed on such a large scale that most companies are very reluctant to stop production and will continue to operate in the short run as long as variable costs are being covered.

Production equipment is specialized and long-lived.

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[22] Carl Kaysen, "Basing Point Pricing and Public Policy," The Quarterly Journal of Economics, XLIII (1949), 290.

[23] Ibid., p. 290.

[24] Ibid., p. 290.

Each fertilizer plant is designed and constructed to manufacture predetermined volumes and specific types of fertilizers. Substitution of products, or an increase in volume without additional capital investment is unlikely.

The market contains only a few sellers so that oligopolistic calculation plays an important role in the action of firms. There are only six manufacturers of nitrogen-phosphate type fertilizers in western Canada.

Kaysen also outlines the following as features of a basing point system in operation.[25]

> "1. Its outstanding feature is the creation of a fixed well-defined price structure with delivered prices by all sellers identical to all consumers at each specific location.
>
> 2. There is always a significant amount of market interpenetration defined as occuring when manufacturers sell to customers located where mill prices plus freight costs from other mills which could handle their orders are lower than from the selling mill."

It is worthwhile to consider both of the above features in respect to the pricing system apparently being employed in western Canada.

Fertilizer prices for a particular fertilizer in western Canada vary according to three factors: whether the fertilizer is bagged or in bulk, the time of year of delivery, and the price zone. It is common practice by all fertilizer manufacturers to

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[25] Ibid., p. 291-292.

allow a five dollar per ton discount for bulk shipments; this saving is warranted by the elimination of many handling charges, in addition to the price of bags. As outlined in Table 13, fertilizer manufacturers try to persuade farmers to store fertilizer for eventual spring use by offering substantial price discounts in the off-season. Farmers who will take delivery of fertilizer in July or August are allowed a six dollar per ton discount over deliveries in the months from March to June of the following year; discounts drop progressively over the winter months until March through June when no discounts are offered.

Table 14 outlines the retail prices for fertilizers in six zones suggested by Cominco Limited and Sherritt Gordon Mines Limited. Map 4 shows the geographical extent of each price zone. Through personal interviews with officials of Western Co-operative Fertilizers Limited and Imperial Oil Limited, the author learned that both these companies and also Northwest Nitro-Chemicals Limited use the same six zone pricing pattern.[26] In appears, therefore, that the basic price of fertilizer to the consumer (on the prairies) is governed by the particular price zone in which the

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[26](a) Personal interview with Mr. K. F. Nielsen, Director of Planning and Product Development, Western Co-operative Fertilizers Limited, on Dec. 28, 1966, on the subject of Western Co-op's marketing of fertilizers.

(b) Personal interview with Mr. A. D. Bull, Transportation and Supply Department, Western Region, Imperial Oil Limited, on Sept. 26, 1968, on the subject of Imperial Oil's marketing of fertilizers.

TABLE 13

An Example of Some Suggested Retail Prices
Per Ton of Several Fertilizers

Sherritt Gordon Mines Limited

Fertilizer	Suggested Price Per Ton			
	July-Aug.	Sept.-Dec.	Jan.-Feb.	Mar.-June
	$	$	$	$
Ammonium Phosphate	97.00	99.00	101.00	103.00
Ammonium Nitrate	75.50	77.50	79.50	81.50
Ammonium Sulphate	49.00	51.00	53.00	55.00
Urea	97.00	99.00	101.00	103.00

Source: Personal interview with Mr. K. Stiles, Economist, Sherritt Gordon Mines Limited, Dec. 2, 1966.

TABLE 14

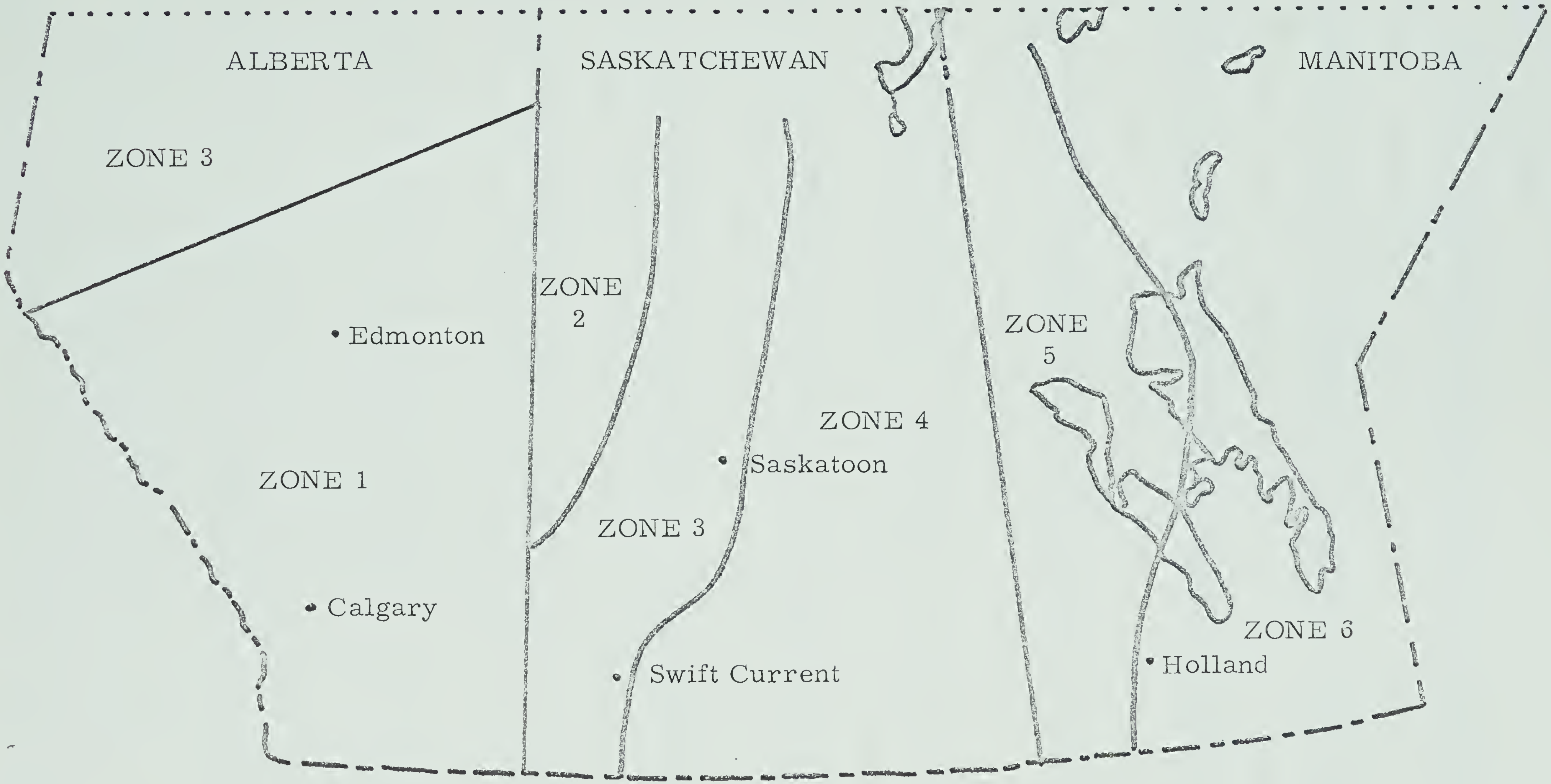
The Suggested Retail Price for Ammonium Phosphate (11-48-0) in Western Canada, June, 1967

Area	Sherritt Gordon	Cominco
	(dollars per ton)	
Zone 1	103.00	103.00
Zone 2	104.00	104.00
Zone 3	105.00	105.00
Zone 4	106.00	106.00
Zone 5	107.00	107.00
Zone 6	108.00	108.00

Source: (a) Personal interview with Mr. K. Stiles, Economist, Sherritt Gordon Mines Limited, Dec. 2, 1966.
(b) Personal interview with Mr. T. C. McBeth, Western Manager, Cominco Limited, Calgary, Dec. 28, 1966.

MAP 2

Pricing Zones, 1966-1967



Source: Personal interview with Mr. K. Stiles, Economist, Sherritt Gordon Mines Limited, Dec. 2, 1966.

consumer is located.

There is a significant amount of market interpenetration by fertilizer manufacturers in western Canada as evidenced by the widespread distribution arrangements with dealers, which were described earlier in this chapter. The adherence to zone pricing is additional evidence of market interpenetration by manufacturers. The effect of this zone pricing is to create for a manufacturer a market area around his plant in which other fertilizer producers, located farther away, can only compete at lower margins. For example, if a farmer located near Fort Saskatchewan buys one ton of ammonium nitrate from Sherritt Gordon Mines Limited and another ton from Northwest Nitro-Chemicals Limited, he will likely pay the same price to both suppliers. However, since the farmer is located near Fort Saskatchewan, Sherritt Gordon pays minimal freight charges and thereby realizes more net margin from the sale than Northwest Nitro, located at Medicine Hat and thus absorbing the transportation costs to Fort Saskatchewan. Of course, should the farmer be located near Medicine Hat, the situation would be reversed. According to Kaysen's criteria, there is strong evidence that the fertilizer manufacturers of western Canada are employing the mechanics of a multiple basing point system in marketing their fertilizers in the western Canadian market.

There has been a great deal of controversy over the practice of basing point pricing. The question which needs clarifi-

cation is whether pricing by a multiple basing point system or an f. o. b. mill basis more nearly results in fair and free competition. Kaysen advocates that where there is a multiple basing point system there is market interpenetration which usually involves freight absorption and always involves selling costs in excess of what would be spent without market interpenetration. According to Kaysen, the end result of market interpenetration is "a complex structure of geographical price discrimination, determined by the locational pattern of mills and customers and the actual degree of market interpenetration".[27]

Bye and Hewett state that "while the practice of basing-point pricing does not necessarily do away with all competition in an industry, it does restrict its operation".[28] These two authors outline in their example of the basing point system (formerly used in the steel industry in the United States) that a basing point system involves discrimination against customers near manufacturing plants. Those customers in close proximity to a mill are prevented from taking advantage of their advantageous location by phantom freight charges. Bye and Hewett suggest that a fairer price system would be for every manufacturer to quote prices f. o. b. the point of manufacture allowing for customers to

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[27] Kaysen, "Basing Point Pricing," p. 292.

[28] R. T. Bye and W. W. Hewett, The Economic Process (New York: Appelton-Century Crafts Inc., 1952), p. 530.

buy where they please and pay for the freight charges themselves.[29]

Clark views the abolishment of the basing point system in favour of f.o.b. mill pricing as merely substituting one form of imperfect competition for another.[30] Clark implies the justification for the basing point practice by denying its reality as anything different from f.o.b. mill pricing plus actual freight. However, the fallacy of Clark's reasoning on this subject is easily shown. As Fetter outlines, "there are two species of delivered prices, innocent f.o.b. mill 'delivered prices' which are the sums of the shipping mills base price and actual freight to a destination, and basing point 'delivered prices' which are the sums of another mills base price plus what the freight would be if the commodity were from that mill. In the one case both prices are real; in the other case both are fictitious and arbitrarily assumed".[31] Therefore, multiple basing point pricing and f.o.b. mill pricing are different pricing systems.

It is useful to compare in further detail the results of f.o.b. pricing and basing point pricing methods in respect to competition and monopoly. Following are some of the more important

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[29] Ibid., p. 530.

[30] J.M. Clark, "Basing Point Methods of Price Quoting," Canadian Journal of Economics and Political Science (November, 1938), 477.

[31] Frank A. Fetter, "Exit Basing Point Pricing," The American Economic Review, XXXVIII, v (December, 1948), 823.

contrasts as outlined by Fetter:[32]

"1. F.o.b. mills do not engage in wasteful cross hauling which adds to their costs; whereas freight absorption under the basing point system leads to cross hauling and adds to the total costs of the industry. Unless the basing point industries can shift this wasteful cost to consumers by charging higher prices, it is reasonable to conclude that they would not favour rentention of freight absorption.

2. F.o.b. mills leave buyers free to deal directly with common carriers; whereas basing point mills deprive shippers of this essential right in a free economic system.

3. The one effective argument of an f.o.b. mill in selling a homogeneous product is a lower base price which results in uniformly lower delivered costs to buyers. Basing point mills do not offer this inducement to buyers, but must resort to costly selling efforts without price or cost inducements, which must be paid for in the long run by the consuming public.

4. F.o.b. mills realize the same net prices on sales to buyers from different destinations as in a regular market; whereas basing point mills absorbing freight, collect higher net realized prices from buyers near the mill, thus reversing their geographical relations.

5. F.o.b. mills are frequently under the pressure of geographical marginal competition not to raise their base prices but rather, in order to retain and attract buyers, to reduce uniformly to all buyers as in a regular market, this being the one effective form of price competition possible, according to the f.o.b. rule, among isolated mills; whereas basing point mills, by absorbing freight, limit to the particular sale the effect of geographical marginal competition upon net realized prices,

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[32] Fetter, "Exit Basing Point Pricing," pp. 823-826.

> while exploiting their monopoly power by continuing to collect higher prices from nearer buyers.
>
> 6. It is apparent that there is in the situation of every more or less isolated enterprise an inherent possibility of monopoly which becomes a certainty with geographical marginal price competition. F.o.b. mill pricing is the sole effective means of preserving and enforcing in large measure this kind of competition; whereas freight absorption under the basing point system exploits that monopoly power to the fullest extent that ingenuity has been able to devise."

It is Smithies view that for manufacturers of identical products the basing point system is a clumsy but automatic devise for protecting competitors from their own self-destructive tendencies.[33] In 1948, the Supreme Court of the United States declared the basing point system to be in violation of the antitrust laws.[34] On the question of public policy as to whether the basing point system (apparently being used in western Canada) should be abolished or retained, it is the author's opinion, based on the foregoing analysis, that this sytem should be abolished in the fertilizer industry of western Canada.

Distributors' commissions are added to the laid-down cost of fertilizer to arrive at the suggested retail selling prices published by manufacturers. The commissions average eight dollars per ton

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[33] Arthur Smithies, "Aspects of the Basing-Point System," The American Economic Review, XXXII, iv (December, 1942), 714-715.

[34] Bye and Hewett, The Economic Process, p. 530.

if a customer purchases a large volume.[35]

(b) Western United States Market

There are no price zones in the western United States and manufacturers maintain no announced price lists; rather, each customer is dealt with on an individual basis. Manufacturers sell some of their products f.o.b. plant and others on a delivered basis. Ammonia is one product sold on an f.o.b. plant basis whereas most solid fertilizers are sold on a delivered basis to the wholesaler. Past customs appear to be the reason for this difference in quoting prices.[36]

In May, 1964, five phosphate fertilizer manufacturers[37] were indicted under Section 1 of the Sherman Act by a grand jury in Los Angeles, California. The indictment charged the five companies with "agreeing, conspiring and taking concerted action to eliminate price competition in dry phosphate fertilizers in the

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[35] Personal interview with Mr. K.F. Nielsen, Director of Planning and Product Development, Western Co-operative Fertilizers Limited, on the subject of fertilizer pricing, Dec. 28, 1966.

[36] Personal interview with Dr. W.E. Duggins, Manager, Marketing Research and Development, Collier Carbon and Chemical Corporation, on the subject of marketing fertilizers in the western United States, June 25, 1969.

[37] Named as defendents were: J.R. Simplot Co., Boise, Idaho; Cominco Products Inc., Spokane, Wash.; Balfour-Guthrie and Co. Ltd., and California Chemical Co., both of San Francisco; and Western Phosphates Inc., Salt Lake City. Names as co-conspirators but not indicted were Anaconda Co., New York City and Northwest Nitro-Chemical Sales Ltd., Alberta.

11 western states from at least 1957 through at least 1961".[38] The indictment specified the following five points on which the companies allegedly agreed:[39]

> "1. To allow a distribution discount only to purchases meeting certain minimum qualifications.
>
> 2. To establish and maintain a uniform differential between the prices of bagged and bulk materials.
>
> 3. To discontinue trucking allowances to purchasers who provide their own transportation from plants.
>
> 4. To apply uniform credit terms.
>
> 5. Amounts and periods of seasonal discounts were agreed upon from time to time.

The indictment stated that "these agreements have restricted price competition among the defendents. Thus farmers, growers and others have bought the products on terms and conditions restricted by agreements among the defendents".[40] From a perusal of the above points in comparison with the pricing information outlined on western Canada, the author concludes that the present pricing practices being employed in western Canada would be illegal under the Sherman Act in the United States.

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[38] "Trustbusters Shift to Phosphate Fertilizer," <u>Chemical and Engineering News</u>, May 11, 1964, p. 23.

[39] <u>Ibid.</u>, p. 23.

[40] <u>Ibid.</u>, p. 23.

(c) World Market

Fertilizer prices on products destined to countries under Colombo Plan aid are the lowest price bids tendered to the Canadian government. All other fertilizers are sold at prices reflecting the existing supply-demand conditions in world markets.

4: PRODUCT COMPETITION

The three major plant nutrients, nitrogen, phosphorus and potash, differ in their function in plant nutrition and therefore cannot be substituted on this basis. Each of these major nutrients should be used in a ratio which is set by the requirements of the plants and the deficiencies of the soils. However, these three major nutrients may still compete on the basis of economic factors. The relative rate of application of the three major nutrients in any one area is also determined by the general acceptance of fertilizer use and by variations in local costs. Local conditions may make one nutrient unusually cheap relative to others. Also, peculiar consumption ratios of the three major nutrients may result because growers apply the nutrients to only one or two major crops.[41]

The possibilities of competition are much greater between the members of each family of fertilizers rather than between the major plant nutrients themselves. Various kinds of fertilizers

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[41] Mirko Lamar, The World Fertilizer Economy (Palo Alto, Calif.: Stanford University Press, 1957), pp. 120-121.

containing nitrogen, for example, may be substituted for each other to a certain degree even though each kind has its particular features. Fertilizers with particular chemical properties may be the most appropriate in certain situations, and physical properties may also result in differentiation. Some fertilizers are more suitable for application by broadcasting methods whereas others lend themselves to side dressing and drilling techniques. Climatic conditions may also dictate the choice of particular fertilizers.

5: PROMOTION

Promotion "is concerned with any method that communicates to the target market about the right product to be sold in the right place at the right price".[42] The aspects of place (distribution) price and product have been discussed in preceeding sections of this chapter. Promotion includes sales promotion, advertising, and personal selling which are all complimentary methods of communicating with customers.

It has been estimated that in the United States more than one-half of the fertilizers used were chosen because of recommendations by salesmen. Agricultural advisors, too, may play an important part in this decision.[43] Personal selling is therefore

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[42] E. J. McCarthy, Basic Marketing: A Managerial Approach (3rd ed.; Homewood, Illinois: D. Irwin Inc., 1968), p. 32.

[43] Lamar, Fertilizer Economy, p. 125.

an important aspect of every fertilizer manufacturer's promotional campaign. In western Canada and the western United States, dealers are backed up by manufacturers' service representatives. In addition to providing free advice to farmers on when, how and where to apply fertilizers, these representatives also inform farmers about the use of better seeds, the proper use of pesticides, proper methods of drainage and crop rotation. Many manufacturers have central soil testing laboratories which analyze soil samples provided by field staff representatives. After the results of soil analyzes are known, the farmers are informed about deficiencies in their soils and are advised as to how these should be corrected.

Although the colour of fertilizers is not of agronomic significance, farmers in certain regions are accustomed to certain colours and their attitudes may be different to fertilizers which are chemically identical. Some manufacturers therefore try to differentiate their products by colour characteristics in advertising campaigns.

CHAPTER VI

PROSPECTS FOR FUTURE GROWTH OF THE FERTILIZER INDUSTRY IN WESTERN CANADA

1: INTRODUCTION

The first section of this chapter relates the current productive capacity of fertilizer manufacturers in western Canada, the western United States and the world with the consumption of fertilizers in each of these markets. Changes in the structure of the fertilizer industry are outlined next in the chapter, followed by an analysis of the prospects for future growth of the industry in western Canada.

2: SUPPLY-DEMAND RELATIONSHIP

The author only undertook a detailed analysis of the pro ductive capacity, by specific type of fertilizer, for the manufacturers of western Canada. Sales by specific type of fertilizer in western Canada have also been outlined so that an analysis of supply-demand relationship by types of fertilizer is possible in the western Canadian market. Although the productive capacity of fertilizer plants in the

western United States and the world have not heretofore been outlined, it is possible to undertake a comparative supply-demand analysis in each of these markets based on the major plant nutrient nitrogen. An analysis based on nitrogen is meaningful because the total production of specific fertilizers from any ammonium-phosphate type fertilizer plant is based directly on the size of the ammonium conversion unit (Chapter II). Therefore, a comparative supply-demand analysis based on nitrogen is indicative of the total supply-demand conditions for all types of ammonium-phosphate type fertilizers in a particular market. The supply-demand relationships for specific fertilizers and nitrogen will be outlined for western Canada first, followed by a supply-demand analysis of nitrogen in the western United States and offshore world markets.

(a) Western Canada Market

The supply-demand situation for specific fertilizers in western Canada is portrayed in Table 15. Establishment of new fertilizer plants and the expansion of old plants has left the western Canada fertilizer industry with almost two-thirds more capacity than required by the domestic market. A comparison of Tables 15 and 3 (page 35) reveals that Cominco Limited alone could easily supply all fertilizer requirements with the exception of ammonium phosphates. Even in the ammonium phosphate category, at present levels of consumption Cominco could provide over 80 per cent of the needed supply. This surplus fertilizer productive capacity in western Canada,

has caused severe competition and thereby lower prices and profits for all manufacturers.[1]

Since the supply-demand analyses for the western United States and offshore world markets are based on nitrogen, it is useful to outline the nitrogen supply-demand situation in western Canada for comparative purposes. In 1968 total nitrogen contained in fertilizers sold in western Canada amounted to 210.7 thousand tons.[2] Fertilizer consumption in western Canada during 1969 is not expected to increase over 1968 levels,[3] and therefore the 1968 consumption of nitrogen may be used in comparison to 1969 productive capacity. With the completion of the Imperial Oil Limited plant, the total ammonia capacity in western Canada is now approximately 930,000 tons annually;[4] it is estimated that about 25 per cent of total ammonia production is destined for non-fertilizer industrial uses.[5] At this percentage the present ammonia capacity available

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[1]"Surplus Fertilizer Sparks Competition," Western Business and Industry, November, 1967, p. 28.

[2]Table C-2, Appendix C.

[3]"Fertilizer Market in Tough Transition," Financial Post, May 10, 1969, p. 41.

[4](a) "Ammonia Producers Swell in Number and Size," Canadian Chemical Processing, June, 1966, p. 59.
(b) Personal letter to the author dated Feb. 28, 1969 from G.W. Carter, Manager, Agricultural Chemicals Division, Imperial Oil Limited, on the subject of Imperial Oil Limited.

[5]Special Report, "When Will Ammonia Turn the Corner?" Farm Chemicals, June, 1969, p. 29.

TABLE 15

The Supply-Demand Relationship by Specific Type of Fertilizer in Western Canada, 1969

Type of Fertilizer	Capacity	Demand	Percentage Demand is of Capacity
	(thousands of tons)		%
Ammonium Phosphates (1)	1,709.0	692.4	40.5
Ammonium Nitrate	510.0	145.8	28.6
Ammonium Sulphate	330.0	31.5	9.5
Urea	220.0	32.1	14.6
Total of All Fertilizers (2)	2,859.0	1,008.3	35.2

Notes: (1) Ammonium phosphates include ammonium nitrate phosphate and all other grades of ammonium phosphates not specified by the Dominion Bureau of Statistics.

(2) Total supply total includes an additional 90,000 tons of nitrogen solutions. The demand total includes an additional 106,500 tons of other fertilizer materials and mixtures not specified.

Source: (a) Capacity - Table 3, p. 35.
(b) Demand - Table 7, p. 50.
Table 8, p. 51.

for fertilizer use in western Canada is 697,000 tons. Currently then, about 30 per cent of the total productive capacity available is being consumed in western Canada.

(b) Western United States Market

In 1968 farmers in the western United States used a total of 2,454.8 thousand tons of nitrogen on their land.[6] The present ammonia productive capacity of all manufacturers in this same area is 4,280 tons annually.[7] If 25 per cent of this total ammonia productive capacity is destined for non-fertilizer uses,[8] then the effective total ammonia capacity available for fertilizer usage is 3,210 thousand tons annually. The present nitrogen supply-demand situation in the western United States is therefore characterized by an excess of supply; annual consumption accounts for approximately 77 per cent of available supply.

(c) World Market

In 1967 the world capacity for total ammonia production approximated 40 million metric tons of which 75 per cent or 30 million metric tons were destined for fertilizer usage. Consumption of total nitrogen in 1967 was estimated at 22 million metric tons. Therefore, on a world scale there was an eight million metric ton

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[6] Appendix D, Tables D-1 to D-16.

[7] Special Report, "When Will Ammonia Turn the Corner?" p. 36.

[8] *Ibid.*, p. 30.

surplus of nitrogen. On a percentage basis this means farmers around the world were absorbing about 73 per cent of the total nitrogen made available to them.[9]

Currently then, all markets served by the fertilizer manufacturers of western Canada have surplus supplies of nitrogen. The most serious over-supply problem exists in western Canada where at least two-thirds of the available productive capacity is not being utilized. Prospects of the future supply-demand conditions in each of these markets are outlined in section four of this chapter. However, since changes in the structure of the fertilizer industry will have a bearing on future supply-demand considerations, these will be outlined next.

3: CHANGING STRUCTURE OF THE FERTILIZER INDUSTRY

The structure of the fertilizer industry is being changed by three interrelated factors which are, the trend to larger plants, changing marketing techniques and the trend to higher analysis fertilizers. Each of these factors will be considered separately.

a. Trend to larger plants

In recent years tremendous strides have been made in reducing the costs of ammonia production by increasing the size of

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[9] J. R. Douglas and Edwin A. Harre, "The North American Fertilizer Industry," (paper presented to the Chemical Institute of Canada, Annual Conference, Vancouver, June 3, 1968).

plants and improving production techniques. Less than ten years ago a 250 ton per day ammonia plant was considered to be large whereas now there are many plants with capacities exceeding 1,000 tons per day.[10] These new plants, by combining the latest manufacturing techniques, high volume production, and low cost raw materials are able to produce ammonia at far less cost than smaller plants. Figure 6 outlines that a 600 ton per day plant is able to manufacture ammonia at significantly lower costs than a 200 ton per day plant, assuming the cost of natural gas is the same for both plants.

Many of the new fertilizer plants are multinational ventures built on or very close to navigable waterways to take advantage of cheaper water transportation. The new ammonia-urea plant at Kenai, Alaska, is typical of the trend in fertilizer plants. Collier Carbon and Chemical Company own and operate the 1,500 tons per day ammonia plant and the 1,000 tons per day urea plant is half owned by Japan Gas-Chemical Company. In terms of end product the plant has excess capacity of 900 tons per day of ammonia which is being barged to Oregon for sale in the western United States market. Collier Carbon also ship their one-half share of urea production (500 tons per day) to the same market.[11]

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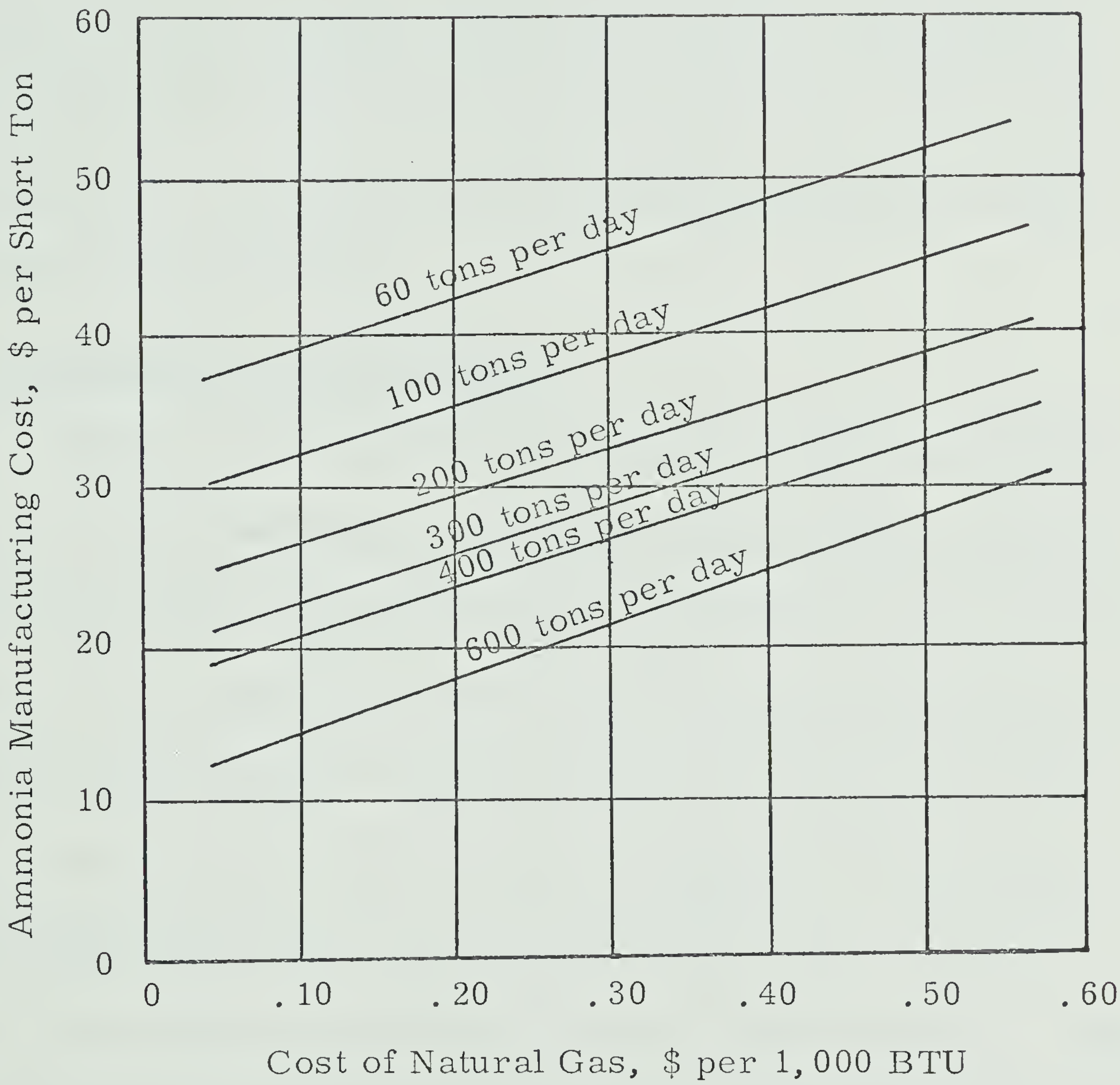
[10]Samuel Stelzoff and Maxim Karafian, "The Design Characteristics of Large Urea Plants," Chemico World, Dec., 1968, p. 10.

[11]Chemical Construction Corporation, "Giant Alaska Fertilizer Complex Nears Completion," Chemico World, Dec., 1968, p. 3.

FIGURE 6

Manufacturing Cost of Ammonia Made From Natural Gas
At Various Single-Train Capacities



Source: Samuel Strelzoff, "Ammonia Manufacturing Processes Completely Change in Ten Years," The Oil and Gas Journal (January 11, 1965), 77.

Imperial Oil Limited's new ammonia plant at Redwater is rated at from 600 to 800 tons per day making it the largest in western Canada. Cominco Limited and Sherritt Gordon Mines Limited both have ammonia plants with a 450 ton daily capacity and the ammonia plants of Western Co-operatives and Northwest Nitro-Chemical are both less than 300 tons per day.[12] Imperial Oil Limited should therefore realize significantly lower costs of production than its competitors if all these companies pay the same price for their natural gas.

b. Changing Marketing Techniques

After a year-long study of fertilizer distribution in Illinois and Iowa, Knoke and Block concluded that the distribution of fertilizers moves out of the hands of independent dealers as the market matures. This movement is from "free" nonintegrated dealers to "captive" dealers owned or sponsored by vertically and horizontally integrated chemical or petroleum companies.[13] Knoke and Block suggest that this movement is the result of the recent entrance of the major oil companies into the fertilizer industry. Many petroleum companies are experienced in integrating from the oil

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[12] "Ammonia Producers Swell," p. 59, and letter from G. W. Carter, Imperial Oil Limited, Feb. 28, 1969.

[13] William Knoke and Carl E. Block, "Market Development Stages of Chemical Fertilizers: A Parallel to the Market Experience of Many Consumer Goods," Business Perspectives, CXXX, (Fall, 1967), p. 58.

well to the gasoline service station; apparently, these petroleum companies feel they can meet competition in the fertilizer business by assuming control of their retail outlets.

The trend suggested by Knoke and Block is evident in western Canada because prior to Imperial Oil Limited's entry into the fertilizer industry, Cominco, Sherritt Gordon Mines and Northwest Nitro-Chemicals all sold their output to independent dealers and grain companies. As outlined in Chapter V, Imperial Oil Limited gained an entry into the western Canadian fertilizer market by sponsoring its farm petroleum agents as fertilizer distributors. Also outlined in Chapter V was the fact that all manufacturers in western Canada now have their own warehouses in various fertilizer consuming areas. Mr. T. B. Potter, President of Northwest Nitro-Chemicals Limited, further confirmed this trend in western Canada by stating "in order to sell surplus capacity producers are buying out distributors and substituting their own fertilizer for established brands. They are building new stores and bulk and bag stations to sell directly to farmers".[14]

The concept of farm service centers is also becoming a reality. These service centers will likely supply a large proportion of the farmers non-machinery requirements in addition to a range of technical and economic services hitherto unmatched in the

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[14] "Surplus Fertilizer Sparks Competition," p. 28.

industry.

Marketing techniques will also be influenced by other factors. Since Canadian banks do not supply loan money to buy fertilizer, manufacturers will be under increasing pressure to extend liberal credit terms if they hope to maintain large sales volumes. The trend to bulk purchases of fertilizers will increase the possibilities of streamlining the present costly distribution systems.

c. Trend to Higher Analyses Fertilizers

Along with the increasing size of fertilizer plants and changing marketing techniques is the continuing search for more highly concentrated fertilizers. Producing highly-concentrated fertilizers at raw material sources is advantageous because of the reduction in the freight cost per unit of plant food delivered. It is significantly more economical per unit of nitrogen to transport a ton of anhydrous ammonia containing 82 per cent nitrogen than a ton of ammonium sulphate at 20.5 per cent nitrogen. A review of Table 7, page 50, outlines the increasing popularity of the newer ammonium phosphates, ammonium nitrate and urea in western Canada.

Fertilizers should be purchased on the basis of their price per pound of plant nutrients rather than price per ton. Then if the newer concentrated fertilizers are not substantially higher in price, they offer the farm consumer better value. This trend

towards higher analyses products also strengthens the position of fertilizer complexes near inexpensive raw materials.

4: PROSPECTS FOR FUTURE GROWTH

The challenges and problems faced by any industry which operates in both domestic and international markets are considerable and the fertilizer industry of western Canada is no exception. This thesis has examined the historical course of the fertilizer industry of western Canada, and it is now useful to outline the most likely developments ahead. In taking a look at the future trends, the author decided to make estimates for 1975 only since the fertilizer industry is changing too rapidly to make a longer forecast worthwhile. For convenience, the variables which may be expected to have an effect on the future demand for fertilizers produced by western Canadian manufacturers are cited in the following two categories, a) domestic considerations, and b) foreign considerations.

a. Domestic Considerations

Successive years of drought, plant diseases or insects could impoverish farmers in western Canada and thereby make investments in fertilizers less than attractive. The large agricultural area of western Canada with similar type crops is susceptible to epidemics of rust (a plant disease), insects or similar pests which would affect tremendous land areas. It is uncertain yet if weather modification is feasible in western Canada. In many years one addi-

tional inch of precipitation at a critical time would probably double the beneficial affects from a given application of fertilizer, and therefore, fertilizer sales could be favourably affected if weather modification became a practical reality.[15]

The general rate of growth of the Canadian economy also has an effect on fertilizer sales. A rising standard of living increases the demand for livestock products on a per capita basis and this in turn has a favourable effect on fertilizer use.

The introduction of new crops and the possibility of new high yielding varieties of wheat or other grains may increase or decrease the demand for fertilizers. Trends to less summerfallowing and more irrigation should have a beneficial effect of fertilizer sales. In addition, an increasing number of farmers are intensifying their livestock programs, and are thereby utilizing increased acreages of forage crops which are fertilized. Increased government and private industry support in the areas of research on the benefits of fertilizer use, soil testing services, credit policies and land use management would have a bearing on the farmer's increasing acceptance of fertilizers.

b. Foreign Considerations

The welfare of the western Canadian fertilizer industry is linked directly to the domestic agricultural industry. Two dominant factors influencing a farmer's purchase of fertilizer are his income during the previous season and the relative value per acre

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[15] Bentley, "Fertilizer Usage in the Prairies," pp. 1-3.

of the crops he grows.[16] As one of the world's major exporters of agricultural produce, Canada's agricultural industry and thereby the fertilizer industry are very much affected not only by domestic supply and demand but also by world market conditions.

The most important development facing future exports of grain from Canada is the recent collapse of the International Grains Agreement. Under this agreement member countries agreed to a scale for world wheat prices. The collapse of the Agreement raises the possibility of a world price war in grains because of bumper harvests in the last two successive years. Both traditional wheat exporting countries and a number of importing countries have experienced large harvests. In the past, Canada had a competitive advantage in world markets because it marketed prime hard wheat. However, other countries are now producing prime wheat and improved milling techniques have reduced the reliance on top grades of grain. These recent developments mean that in order to compete in world markets Canada will have to lower its prices and this will mean less money for the wheat farmers in western Canada and thereby less money to purchase fertilizers.[17] If Canada is unable to sell all of its exportable wheat on the world market the result will be small grain delivery quotas in the prairie provinces. Under the grain quota system in Canada, the farmer is guaranteed the sale of a set number of bushels per acre. Small

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[16] Lamar, Fertilizer Economy, p. 85.

[17] "Canada Fears U.S. Price Cuts Could Start Wheat Sales War," Edmonton Journal, July 19, 1969, pp. 1-2.

quotas discourage high yields and efficient farming, and they have an adverse effect on fertilizer demand.[18]

The disposal policies for agricultural products by the United States have an effect on Canadian agriculture. Support programs have resulted in a continuing increase in production of wheat in the United States and as a consequence wheat exports have increased. As of June, 1969, the United States has an estimated carry-over of 700-775 million bushels of wheat. This carry-over will likely result in further increases in exports and more price cutting on the world market, which will have adverse effects on Canadian wheat sales.[19] It should be noted that farmers in the United States do not adhere to a grain quota system like the one under which Canadian agriculture is governed; American farmers are paid not to farm a certain acreage of their farms and this practice has spurred the increased use of fertilizer on the land that is cultivated.

Since western Canadian fertilizer manufacturers sell a portion of their production in offshore markets and the western United States, future supply-demand possibilities in these two markets have a bearing on the expected growth of the industry in western Canada. Figure 7 graphically outlines the expected future

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[18] Bentley, "Fertilizer Usage in the Prairies," p. 4.

[19] C. K. Nash, "Market for Wheat Falls Off: Exporters Outlook is Bleak," Financial Post, March 1, 1969, p. 8.

supply-demand relationships for nitrogen in world markets and the western United States. The world ammonia productive capacity destined for fertilizer use is expected to increase from the approximate 30 million ton capacity in 1967 to about 45 million tons by 1971. World consumption of nitrogen in 1971 is expected to increase to about 29 million tons annually from a 1967 figure of 22 million tons.[20] This represents an eight per cent per year increase and if this growth rate is projected to 1975,[21] then the world consumption of nitrogen should approximate 41 million tons annually. Therefore, even with expected growth rates it will probably be after 1975 before consumption of fertilizer nitrogen in world markets reaches an equilibrium point with supply. This assumes that no additional ammonia capacity is constructed in excess of the 15 million tons considered in the projection. Western Canadian fertilizer manufacturers may therefore expect severe competition in world fertilizer markets at least until 1975 because of a world surplus of nitrogen.

There are presently some widely differing opinions regarding the expected growth rate of the consumption of nitrogen in the United States. Some observers feel growth in consumption

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[20] Douglas and Harre, "North American Fertilizer Industry," p. 3.

[21] Special Report, "When Will Ammonia Turn the Corner?" p. 34.

should be compounded at 10 per cent annually whereas others look for a growth rate of five per cent annually.[22] The author has found no sound reasons for subscribing to one of these projections in preference to the other, and therefore the consequences of both will be considered.

As outlined in Figure 7, if no additional ammonia capacity is constructed, a balance between supply and demand in the western United States could be reached as early as 1971 or as late as 1974. Therefore, western Canadian fertilizer manufacturers are faced with the prospect of severe competition in the western United States market until at least 1971 and possibly until 1974.

From an international standpoint the marketing prospects for the fertilizer manufacturers of western Canada do not look favourable in the time period up to 1975. Future over-supply conditions in both the western United States and world markets will make it increasingly difficult for the fertilizer manufacturers of western Canada to compete in these markets.

c. Prospects for Future Growth

What are the prospects for future growth of the fertilizer industry in western Canada? The present over-supply conditions for fertilizer in western Canada, the western United States and world markets are detrimental to capital expenditures on new plants

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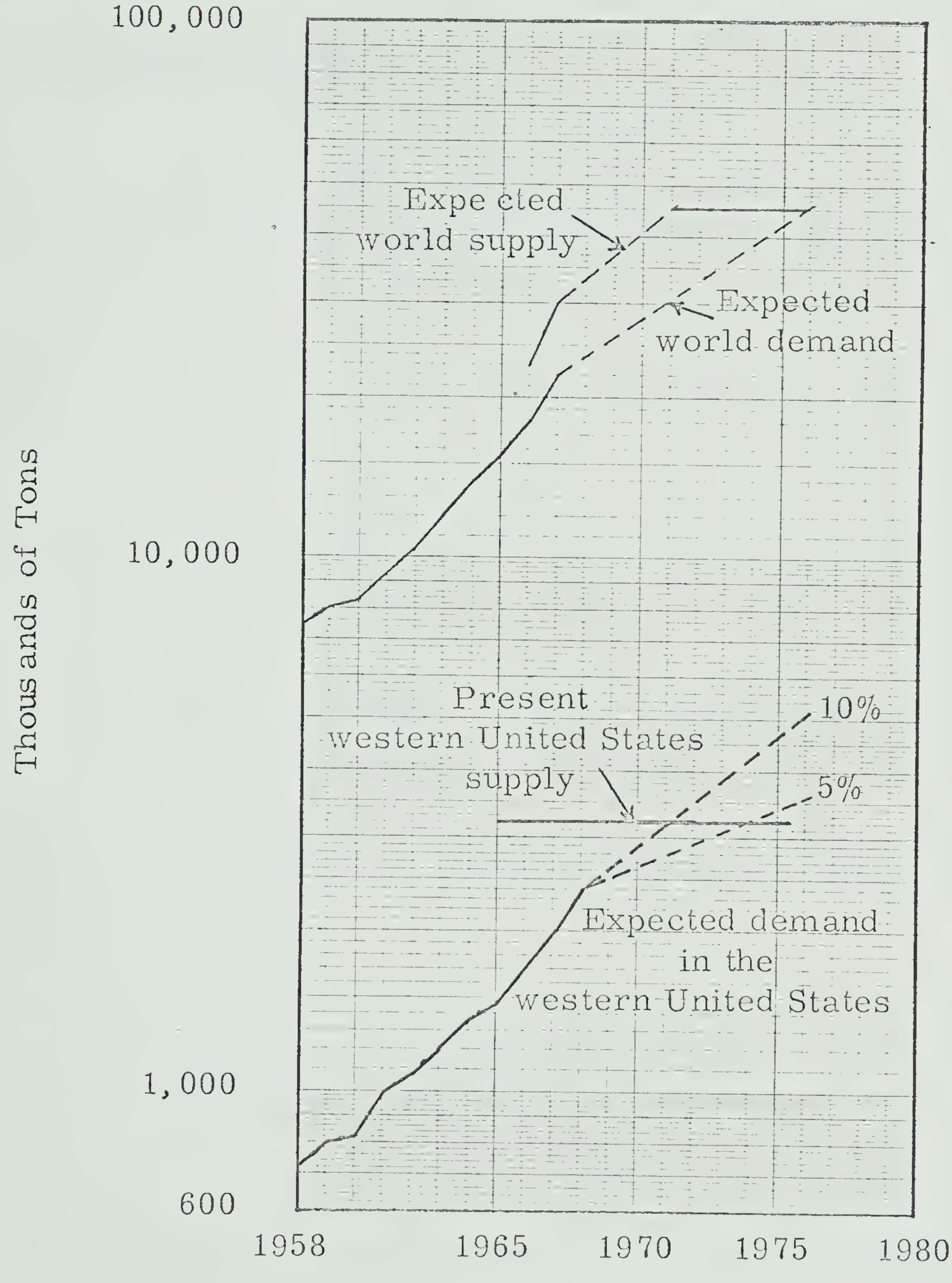
[22] Ibid., p. 30.

FIGURE 7

The Present and Future Supply-Demand Relationships of Nitrogen
In the Western United States and World Markets



Note: Tons are in metric figures for the world market and short-ton Tons for the western United States market.

Source: (a) Douglas and Harre, "North American Fertilizer Industry," p. 3.
(b) Appendix D, Aggregation of Tables D-1 to D-16
(c) Special Report, "When Will Ammonia Turn the Corner?" p. 36.

in any of these markets. As outlined, these over-supply conditions will likely continue well into the 1970's in the western United States and in world markets. Therefore, western Canadian fertilizer manufacturers will not find it easy to dispose of their excess production in these two markets.

The author concludes that the trend to large multinational ammonia plants, based on low-cost natural gas and adjacent to navigable water, will also lessen the chances of western Canadian producers competing in foreign markets in the future. Already this trend has affected the marketing of fertilizers in the western United States market; as outlined, Collier Carbon and Chemical are able to compete in the western United States market from their large fertilizer plant in Alaska. Low-cost natural gas is available in many areas of the world adjacent to navigable water and companies desiring to compete in international markets will establish in these areas.

The distribution of ammonia by pipeline to the mid-western region of the United States from new large plants on the Gulf Coast may soon become a reality. This marketing trend may seriously affect the competitiveness of fertilizers from western Canada.

Western Canadian manufacturers have kept up with the trends to higher analysis fertilizers. Therefore, they are not at a competitive product disadvantage with the current type of fertilizers being manufactured.

Other acids besides sulphuric acid may be used as acidulants in the future. If any of these processes are perfected then the advantage western producers have of being close to sources of sulphur may not matter a great deal in the future.

The foremost factor in future prospects for the western Canadian fertilizer industry is the price prairie farmers receive for their wheat. This factor has a far greater effect on domestic sales of fertilizer in western Canada than any of the other domestic factors.[23] Since the western Canadian fertilizer industry is primarily concerned with supplying the domestic western Canadian market, wheat sales and prices dictate the future of the fertilizer industry. Farmers in western Canada had a realized net income of $1,056 million in 1966, $1,040 million in 1967 and $921 million in 1968.[24] Disappointing world wheat sales in 1967 and 1968 resulted in lower net incomes to farmers. The significantly lower income in 1968 and poor spring planting weather this spring have made some fertilizer representatives predict a 10 - 12 per cent reduction in fertilizer sales in 1969 compared to 1968.[25] With the recent collapse of the international Grains Agreement and prospects of an oversupply of wheat in world markets, the future outlook for

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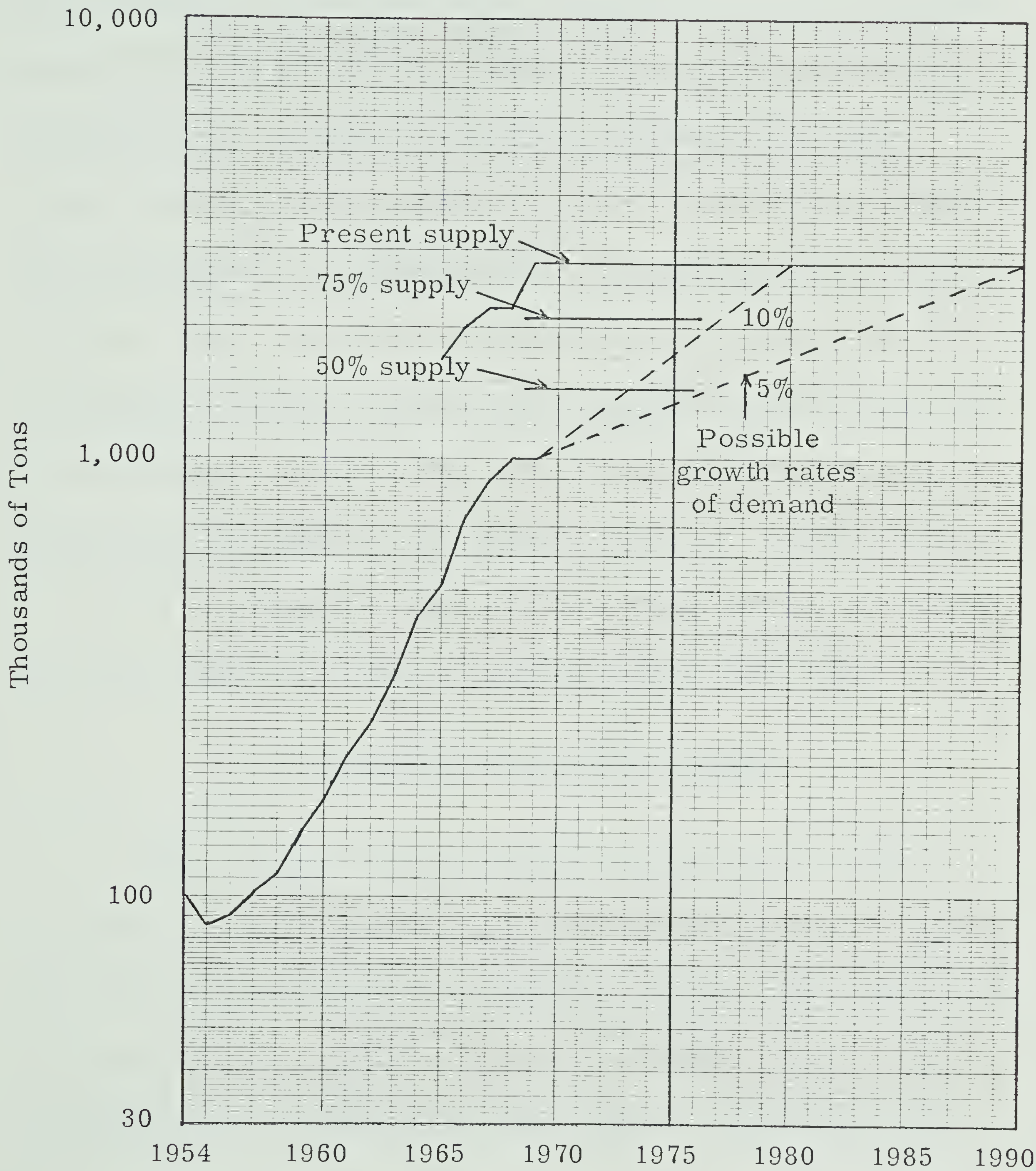
[23]Bentley, "Fertilizer Usage in the Prairies," p.4.

[24]Canada, Dominion Bureau of Statistics, Farm Net Income 1968, Catalogue No. 21-202 (Ottawa, Queen's Printer, 1968), p.4

[25]W. L. Dach, "Fertilizer Sales Hopes Turn to Dust," Financial Post, May 10, 1969, p. 1.

FIGURE 8

The Present and Future Supply-Demand Relationship of Fertilizer in Western Canada



Source: (a) Table 8, p. 51.
(b) "Ammonia Producers Swell," p. 59.
(c) Letter from G. W. Carter, Imperial Oil, dated Feb. 28, 1969.

demand of Canadian wheat is not promising.

J. Douglas of the Tennessee Valley Authority and T. Blue of Stanford Research Institute both predict annual increases of less than 10 per cent in domestic sales of fertilizers in the United States between now and 1975.[26] The author concludes from the factors outlined in this chapter that it is most improbable that annual growth rates for fertilizer sales in western Canada could surpass those projected for the United States. It is obvious from a review of Figure 8 that even at an annual growth rate of 10 per cent, the over-supply conditions facing western Canadian fertilizer manufacturers will not be alleviated by 1975. At an annual growth rate of 10 per cent the supply-demand balance will occur in 1980 whereas if the annual growth rate of fertilizer consumption is as low as five per cent, supply surpluses will still exist until about 1990.

5: SUMMARY AND CONCLUSIONS

The nitrogen phosphate fertilizer industry of western Canada is presently faced with a long period of excess plant capacity. The future welfare of the fertilizer industry will be primarily determined by the success or failure of the Wheat Board to sell Canadian wheat profitably in foreign markets. If there is a shift in Canadian agriculture from grain to livestock production, then

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[26]Special Report, "When Will Ammonia Turn the Corner?" p. 34.

dependence on foreign wheat sales will be less critical in the future. However, any major shift to a livestock economy will likely take a substantial number of years to complete.

The western United States market will continue to be the prime foreign market for western Canadian manufacturers because new large ammonia plants, based on low-cost natural gas and adjacent to navigable water, will compete in offshore world markets. Foreign policies of the United States may severely damage the fertilizer industry of western Canada. If the United States decides to aggressively market its grain in foreign markets, this may have a very damaging effect on wheat sales from Canada and thereby on the fertilizer industry.

It is acknowledged that this study is incomplete in that the author did not take into account the future possibilities of the fertilization of forests and the fertilizers based on coal and acids, in addition to sulphuric acid. Also, the advantages and disadvantages to the farm consumer of the present pricing system for fertilizers in western Canada warrant further investigation. However, this thesis has consolidated in a meaningful form the various aspects of the present nitrogen-phosphate industry of western Canada and has provided an insight into future prospects for this industry.

APPENDIX A

PLANTS AND NUTRIENTS

APPENDIX A

PLANTS AND NUTRIENTS

A growing plant requires at least sixteen nutrient elements to survive. Nine of these elements, commonly referred to as macronutrients, are required in relatively large quantities, whereas the other seven elements, the micronutrients, are needed in smaller amounts.[1] The nine macronutrients and the seven micronutrients needed by plants are listed below:

Macronutrients	Micronutrients
carbon	boron
hydrogen	copper
oxygen	iron
nitrogen	manganese
phosphorus	zinc
potassium	molybdenum
calcium	chlorine
magnesium	
sulphur	

Most plants obtain carbon, hydrogen and oxygen from the air and all the other nutrient elements from the soil. Of the six remaining macronutrients, nitrogen, phosphorus and potassium are conveniently classified as the primary elements; calcium, magnesium and

[1] Christopher J. Pratt, "Chemical Fertilizers," Scientific American, June, 1965, p. 63.

sulphur are the secondary elements.[2]

Continuous usage of the soil decreases particularly the amount of primary elements available in the soil. This fact is indicated in Table A-1. The fertilizer industry is based on providing suitable products which replenish the soil's natural reserves of nitrogen, phosphorus, potassium and sulphur. Calcium, magnesium and various micronutrients are sometimes added to fertilizers; however, the prairie soils of western Canada and the soils of the Great Plains area of the United States are generally adequately supplied naturally with these nutrients.[3]

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[2]Cominco Limited, Planting for Profit (Trail, B. C.: Cominco Limited, n. d.), p. 4.

[3]*Ibid.*, p. 5.

TABLE A-1

The Approximate Number of Pounds of Plant Food Removed Per Acre by Selected Crops

Crop	Yield Per Acre	Part of Crop	Number of Pounds of Plant Food Removed		
			Nitrogen	Phosphorus	Potassium
Wheat	30 bushels	grain	35	16	19
	1 1/4 tons	straw	15	4	21
Oats	50 bushels	grain	35	15	10
	1 1/4 tons	straw	15	5	35
Barley	40 bushels	grain	35	15	10
	1 ton	straw	15	5	30
Corn	100 bushels	grain	78	36	36
Flax Seed	840 pounds	seed	32	10	8
Timothy	2 tons	all	53	20	60
Sugar Beets	15 tons	roots	55	22	53
Potatoes	500 bushels	tubers	108	42	192

Source: Planting for Profit, p. 8.

APPENDIX B

CHEMISTRY AND PRODUCTION TECHNIQUES

APPENDIX B

CHEMISTRY AND PRODUCTION TECHNIQUES

Complete coverage of the chemistry and production techniques of fertilizer manufacture are not relevent to this study. Accordingly, this appendix will be confined to a brief description of the chemical reactions taking place, and the basic production processes involved in manufacturing fertilizers, which are currently produced either by plants in western Canada or in the marketing areas presently served by these establishments.

1: THE ARC PROCESS OF NITROGEN FIXATION

In the arc process, the reaction between nitrogen and oxygen is performed by blowing air through a flaming electric arc, which has a temperature of about 3500°C. Less than 2 per cent of the heated air is caused to combine. The reactions involved are about as follows:[1]

$$N_2 + O_2 \longrightarrow 2NO$$

$$2NO + O_2 \longrightarrow 2NO_2$$

The nitric dioxide produced is then converted into nitric acid by the action of water and atmospheric oxygen:

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[1]Collings, Commercial Fertilizers, p. 79.

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

2: THE CYANAMIDE PROCESS OF NITROGEN FIXATION

The four separate steps involved in the Cyanamide Process are as shown below:[2]

1. The production of lime by burning calcitic limestone in a vertical or rotary kiln at about 1100°C. The limestone is decomposed as follows:

   $$CaCo_3 + \text{heat} \rightarrow CaO + CO_2$$

2. Calcium carbide is produced by reacting the lime (calcium oxide) formed with coke or coal in an electric furnace at 2200°C. This reaction is expressed by the equation:

   $$CaO + 3C \rightarrow CaC_2 + CO$$

3. The production of pure nitrogen gas from the air by liquification and fractional distallation.

4. The reaction of the finely powdered calcium carbide with pure nitrogen at approximately 1000°C to form cyanamide. This reaction is represented by the equation:

   $$CaC_2 + N_2 \rightarrow CaCN_2 + C$$

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[2] Ibid., p. 81.

3: THE DIRECT SYNTHETIC AMMONIA PROCESS OF NITROGEN FIXATION

A. Preparation of Hydrogen and Nitrogen

Preparation of Hydrogen. - There are several sources of hydrogen required in the ammonia synthesis. The well-known "water-gas method" is one of the oldest methods of preparing hydrogen. This method involves the reaction of incandescent carbon with superheated steam. The reaction taking place is represented by the following equation:[3]

$$C + H_2O \rightarrow CO + H_2$$

Hydrogen may also be obtained from the "electrolytic decomposition of water". In areas where electric power is cheap, particularly in Italy and Norway, this process is used. Only one installation for producing hydrogen by the electrolysis of water exists in the North American continent and this is the Trail, British Columbia plant of Cominco Company, Limited. The principle equation involved in the electrolysis of water is as follows:[4]

$$2H_2O \rightarrow 2H_2 + O_2$$

Presently, the most important source of hydrogen in North America and the predominant source in western Canada is the "steam-methane" process. In general practice preheated natural gas, from which the sulphur has been removed, is mixed with superheated steam

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[3] Tisdale, Soil Fertility, p. 132.

[4] Jacob, Fertilizer Technology, p. 39.

and passed through tubes containing a nickel oxide catalyst. The reaction, shown by the following equations, takes place at a pressure of about 40 pounds per square inch at a temperature of $700^{\circ}C$:[5]

$$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$$

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

By subsequent treatment the carbon monoxide is reduced and the hydrogen gas rendered suitable for ammonia synthesis as follows:

$$CO + H_2O \rightarrow CO_2 + H_2$$

Another source of hydrogen is "by-product hydrogen" from petroleum refineries. Several refineries have ammonia-fixation plants adjacent to them because of the by-product hydrogen.

Preparation of Nitrogen. - Nitrogen may be prepared by the fractional distallation of liquid air -- the "Linde Process". This process consists of liquefying air and then allowing it to warm slowly, thus distilling off the nitrogen. Tail gas (which contains about 95 per cent nitrogen) from ammonia oxidation plants also affords a source of concentrated nitrogen. Cominco commenced recovery of nitrogen (about 100 tons per day) from this source shortly after 1941.[6]

Most of the nitrogen now being used today is secured by burning natural gas in a forced draft of air. The oxygen of the air combines with the carbon of the natural gas to form carbon dioxide and carbon

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[5] Tisdale, Soil Fertility, p. 132.

[6] Jacob, Fertilizer Technology, p. 40.

monoxide, while the nitrogen remains unchanged.[7]

B. Purification and Compression of the Hydrogen and Nitrogen Gases Produced

Purification of the Gases. - The basic catalyst (iron oxide) used in ammonia synthesis is extremely sensitive to impurities, such as carbon monoxide, carbon dioxide, water vapour and sulphur compounds. Therefore, all these impurities are reduced to a few parts per million before the nitrogen and hydrogen gases enter the synthesis chamber.[8]

Compression of the Gases. - One of the major costs of ammonia synthesis is the compression of nitrogen and hydrogen. Although this is a costly step, little comment is required. Compression of nitrogen and hydrogen is accomplished in multistage compressors driven by natural gas, steam or electricity depending on the availability of these sources of power. Throughout the compression and purification steps, the mixture of hydrogen and nitrogen gas is saturated with water. However, as the system pressure increases, the water content becomes increasingly small, and it may be finally removed by refrigeration or absorption.[9]

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[7] Collings, Commercial Fertilizers, p. 79.

[8] Jacob, Fertilizer Technology, p. 34.

[9] Ibid., pp. 40-41.

C. Ammonia Formation by the Synthesis of Hydrogen and Nitrogen

The purified and compressed mixture of hydrogen and nitrogen gases -- labelled "Synthesis Gas" -- is passed over a catalyst (usually iron oxide) in a mixture of three parts of hydrogen to one part of nitrogen. Synthesis of this mixture is carried out at pressures ranging from 100 to 1000 atmospheres, and within the temperature range 400 - 650°C.[10] The reaction taking place is expressed generally by the following equation:

$$3H_2 + N_2 \longrightarrow 2NH_3$$

With modern equipment about 18 per cent of ammonia is made at each pass of the mixture through the converter. Unconverted gas is recycled through the converter, while at the same time another supply of unconverted gas is introduced into the system by the main compressors.[11] The ammonia produced is recovered by absorption and refrigeration.

4: THE MANUFACTURE OF SULPHURIC ACID

Both the "chamber process" and the "contact process" for the production of sulphuric acid involve the burning of elemental sulphur or pyrites to produce sulphur dioxide. The differences between the two processes are in the manner in which sulphur dioxide is converted

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[10] Collins, Fertilisers, p. 62.

[11] Ibid., pp. 62-63.

to sulphur trioxide and absorbed in water to produce sulphuric acid.[12]

In the chamber process (so-called because the reactions which produce sulphur trioxide and sulphuric acid take place within a lead-lined chamber), conversion of sulphur dioxide to sulphur trioxide and then to sulphuric acid is made possible by the use of nitrogen oxides as oxygen carrying catalysts. These nitrogen oxides are injected into the sulphur dioxide in a chamber where the formation of sulphur trioxide and its hydration to sulphuric acid occur.

In the contact process, sulphur dioxide is converted to sulphur trioxide in the presence of a solid catalyst usually vanadium oxide in newer plants, although platinum and iron oxide are still used. The sulphur trioxide is passed to a tower where it is absorbed in recycling concentrated 98 per cent sulphuric acid. The reactions taking place are represented by the following equations:[13]

$$S + O_2 \rightarrow SO_2 + \text{heat}$$

$$2SO_2 + O_2 \rightarrow 2SO_3 + \text{heat}$$

$$SO_3 + H_2O \rightarrow H_2SO_4 + \text{heat}$$

A simplified flow diagram for a contact sulphuric acid plant using either pyrites or elemental sulphur is shown in Figure B-1. Depending on raw materials and other considerations, there are many variations of the contact process.

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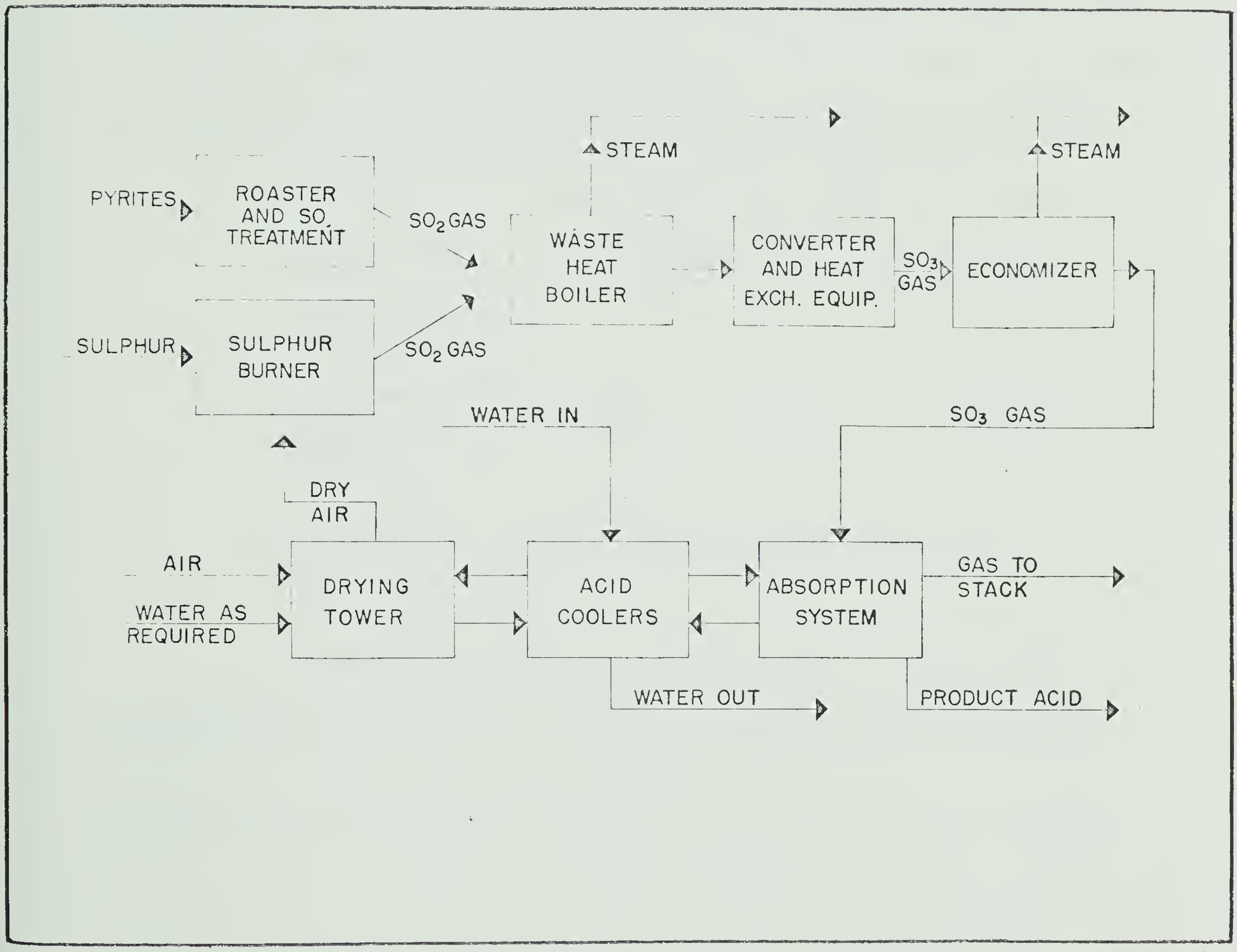
[12] Jacob, Fertilizer Technology, p. 73.

[13] Ibid., p. 73.

FIGURE B-1

Flow Diagram of the Contact Sulphuric Acid Process



Source: David W. Bixby and others, Phosphatic Fertilizers: Properties and Processes, Technical Bulletin No. 8 (Washington: The Sulphur Institute, 1966), p. 5.

5: THE MANUFACTURE OF WET-PROCESS PHOSPHORIC ACID

The major principal reaction taking place in the manufacture of wet-process phosphoric acid probably is best represented by the following equation:[14]

$$Ca_{10}(PO_4)_6F_2 + 10H_2SO_4 + 20H_2O \rightarrow 10CaSO_4 \cdot 2H_2O + 6H_3PO_4 + 2HF$$

Although individual installations for the production of wet-process acid vary considerably, the four main steps of the process are as follows:[15]

a. The reaction of finely ground phosphate rock and sulphuric acid to form phosphoric acid and calcium sulphate (gypsum).

b. Separation of the calcium sulphate from the acid by filtration.

c. Washing the calcium sulphate to remove residual phosphoric acid.

d. Concentration of the acid by heating in an evaporator.

A simplified flow diagram of the basic process for the production of wet-process acid is given in Figure B-2.

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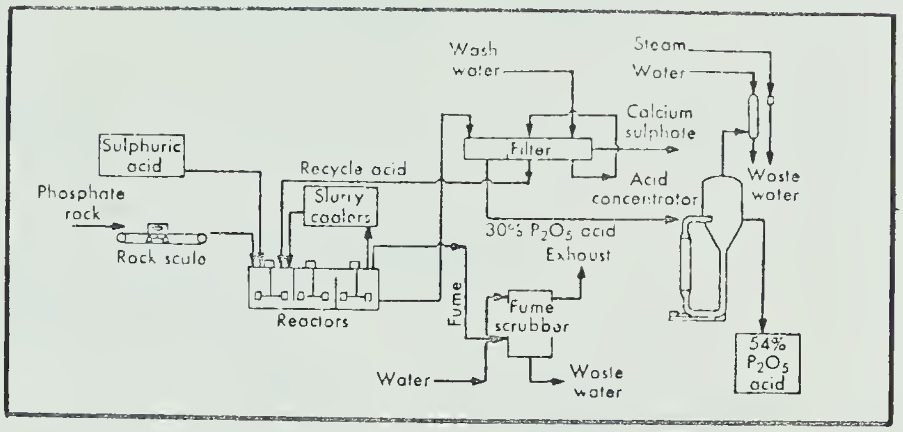
[14] Bixby, <u>Phosphatic Fertilizers</u>, p. 9.

[15] United Nations Industrial Development Organization, <u>Fertilizer Manual</u> (New York: United Nations, 1967), p. 126.

FIGURE B-2

Flow Diagram of a Wet-Process Phosphoric Acid Plant



Source: Fertilizer Manual, p. 126.

6: THE MANUFACTURE OF NORMAL SUPERPHOSPHATE

There are three steps involved in manufacturing normal superphosphate. Firstly, equal parts of phosphate rock and 54 - 57^{o} Be sulphuric acid are mixed together. Secondly, the mix is allowed to assume a solid form, which is known as "denning". Finally, the solid mass is stored (curing) to allow for the completion of the acidulation reaction. The general reaction taking place may be represented by the following equation:[16]

$$Ca_{10}(PO_4)_6F_2 + 7H_2SO_4 \longrightarrow 3Ca(H_2PO_4)_2 + CaSO_4 + 2HF$$

Normal superphosphate may be manufactured in small inexpensive plants with a low production cost per unit of phosphorus. Figure B-3

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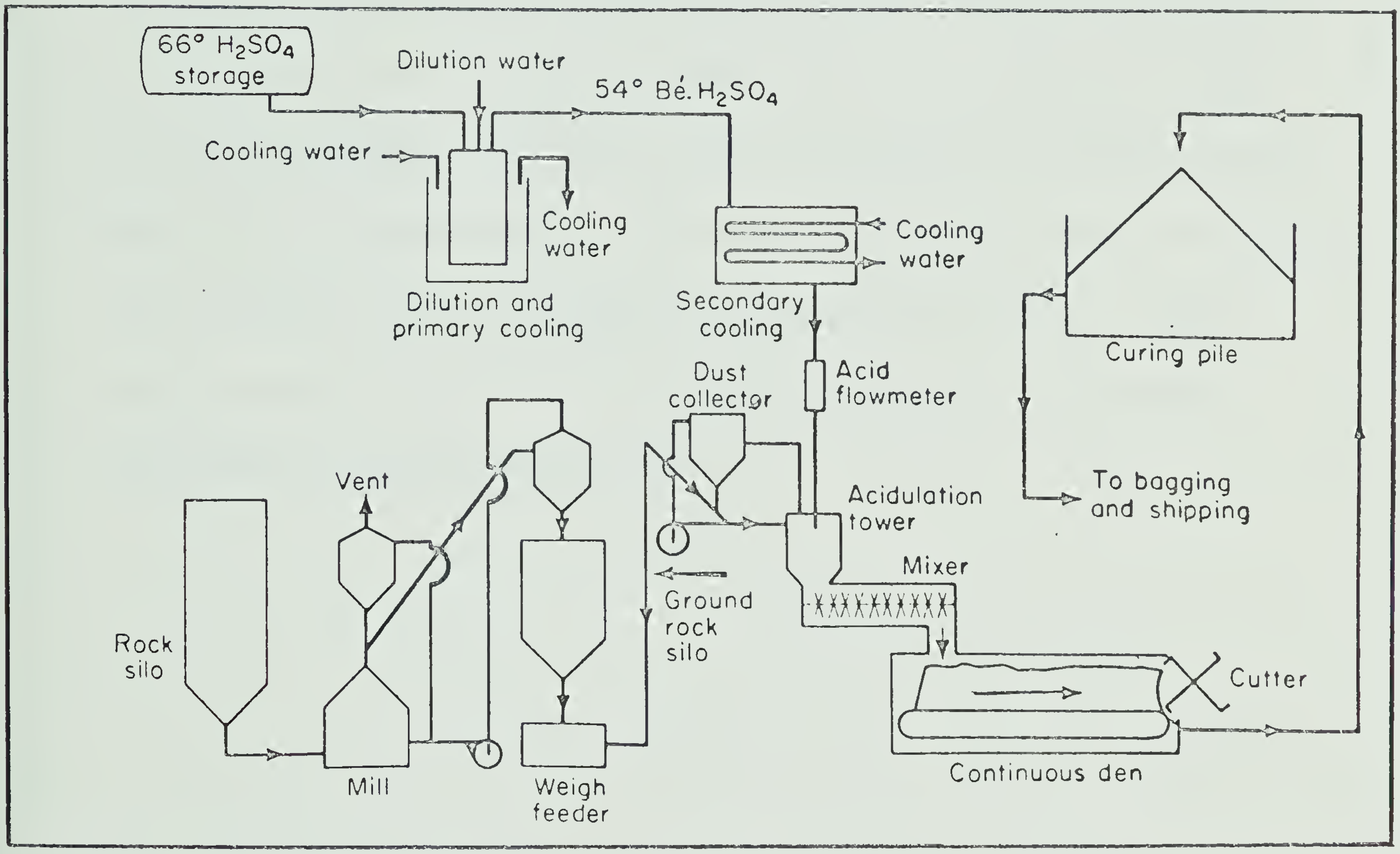
[16] Bixby, Phosphatic Fertilizers, pp. 6-8.

depicts the flow diagram for a continuous plant.

FIGURE B-3

Continuous Process for the Manufacture of
Normal Superphosphate



Source: Bixby, Phosphatic Fertilizers, p. 7.

7: THE MANUFACTURE OF TRIPLE SUPERPHOSPHATE

In the manufacture of triple superphosphate, phosphate rock and phosphoric acid are mixed, the acidulate is "denned" and the solidified triple superphosphate is cured in storage. Triple super-

phosphate solidifies much more rapidly than normal superphosphate and the two operations differ mainly in that respect.

Presently, there are three principal methods of manufacturing triple superphosphate. One of these produces a pulverized product which, being soft and porous, is particularly suited to the manufacture of ammoniated fertilizers. The second method produces a granulated product in a multi-step process which is well suited for direct application as a phosphate fertilizer, or for inclusion in mixed bulk blends made by dry blending solid raw materials. The third method combines the features of quick drying and granulation in one step.[17] Triple superphosphate is now largely produced by means of a continuous process as outlined in Figure B-4.

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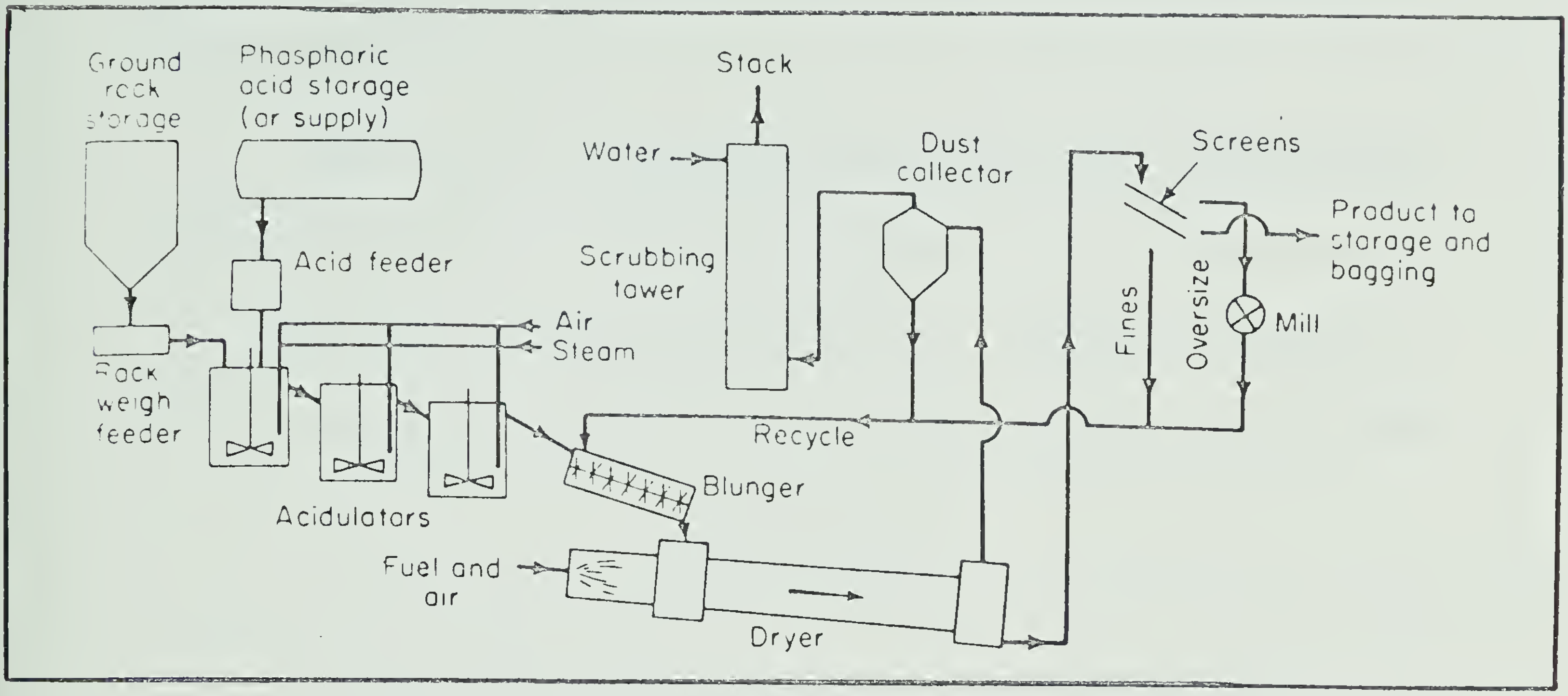
[17] Ibid., pp. 14-15.

FIGURE B-4

Continuous Process for the Manufacture of
Granular Triple Superphosphate



Source: Bixby, Phosphatic Fertilizers, p. 15.

8: THE MANUFACTURE OF AMMONIUM SULPHATE

Today, ammonium sulphate is usually made by one of the following methods:

a. The direct reaction of ammonia with sulphuric acid, is the universal process where there is an adequate supply of sulphur.

b. The reaction of ammonium carbonate with calcium sulphate which occurs naturally as either anhydrate or gypsum.[18]

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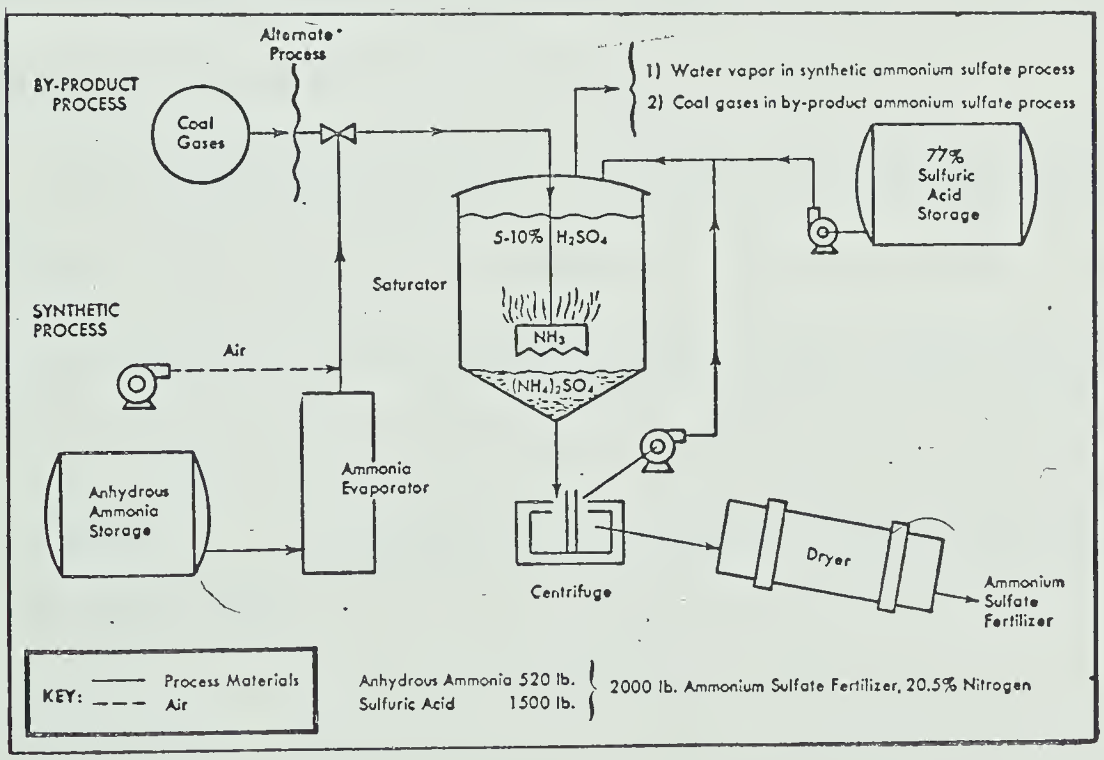
[18] Collins, Fertilisers, p. 63.

This latter process is used chiefly in countries without indigenous sulphur supplies, but having natural or by-product sources of gypsum. Since sulphur supplies are adequate in both Canada and the United States, only the first method of manufacturing ammonium sulphate will be briefly described.

The synthetic-ammonia process for making ammonium sulphate involves the use of anhydrous ammonia, which is introduced into dilute sulphuric acid (see Figure B-5). Anhydrous ammonia, which is vaporized, is introduced into dilute sulphuric acid through

FIGURE B-5

Diagram of the Manufacture of Ammonium Sulphate



Source: Jacob, Fertilizer Technology, p. 75.

a distribution head located in the lower section of the saturator. The

sulphuric acid is injected into the circulation system and enters from above. The reaction supplies heat for vaporization of the water, which is assisted by air introduced along with the ammonia gas. Ammonium sulphate crystals collect at the bottom of the saturator, from where they are withdrawn, centrifuged and dried. The filtrate is recycled to the saturator. In this process the reaction taking place may be represented by the following equation:[19]

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4 + \text{heat}$$

9: THE MANUFACTURE OF AMMONIUM PHOSPHATE

Two general processes are used for the production of ammonium-phosphate, granulation and crystallization. Since the crystallization process is dependent upon by-product gases from the coke industry, its use is limited and the details of this process will not be outlined.

The granulation process is favoured over the crystallization process for manufacturing ammonium phosphate, because it permits the use of low-cost wet-process phosphoric acid. Basically, in the granulation process, wet-process phosphoric acid is neutralized in a series of tanks.[20] A simplified flow diagram of this process is presented in Figure B-6.

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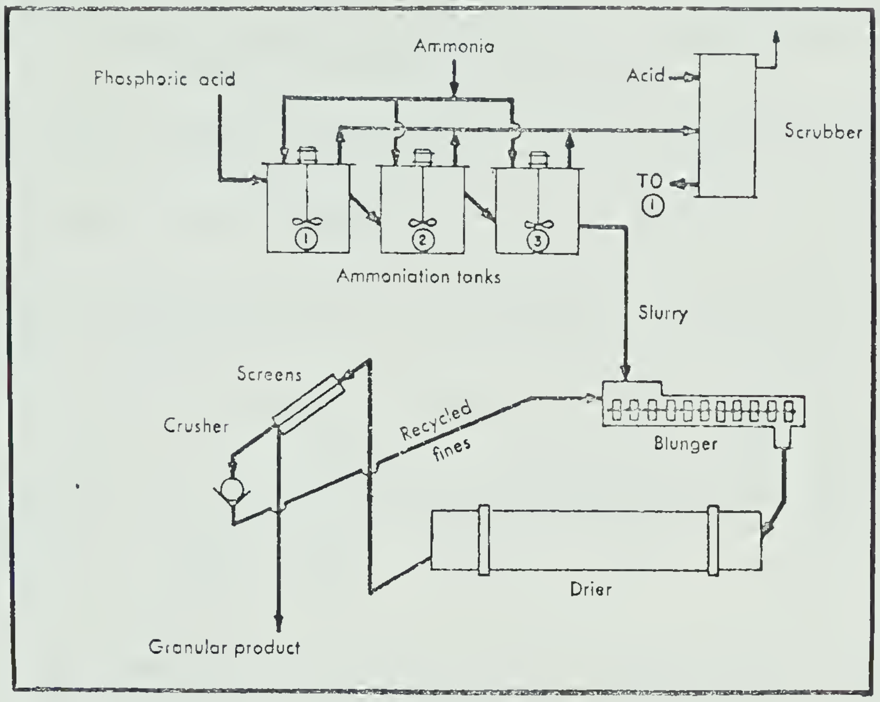
[19] Jacob, Fertilizer Technology, p. 76.

[20] Fertilizer Manual, p. 154.

FIGURE B-6

Flow Diagram of the Manufacture of Ammonium Phosphate



Source: Fertilizer Manual, p. 154.

The extent of ammoniation is controlled to produce (a) mono-ammonium phosphate, (11-48-0); (b) a mixture of mono and diammonium phosphate, (16-48-0); or (c) essentially an all diammonium phosphate, (18-46-0). Granulation is accomplished in a blunger mill (thickener), where the slurry from the ammoniation tanks is mixed with recycled "fine" from the screens.

In newer plants, a rotary drum granulator is being substituted for the blunger because this procedure means less drying equipment is needed. By adding sulphuric acid to the ammoniating tanks, phosphate

sulphates of such grades as 13-39-0 and 16-20-0 are produced. The latter product contains more than half ammonium sulphate.[21]

10: THE MANUFACTURE OF NITRIC ACID

The development of the "ammonia-oxidation" process for making nitric acid relieved the world of its dependence on sodium nitrate (principally from Chile) as a raw material of nitric acid for chemical and technical uses. In addition, the ammonia-oxidation process provided the fertilizer industry with another important source of nitrate nitrogen. The principal steps of the ammonia-oxidation process consist of:[22]

a. The burning of ammonia (in contact with a platinum catalyst) to nitric oxide (NO).

b. Oxidation of the nitric oxide to nitrogen dioxide (NO_2).

c. Absorption of the nitrogen dioxide in water to form nitric acid.

The above steps may be represented by the following equations:[23]

$$4\,NH_3 + 5O_2 \rightarrow 4\,NO + 6H_2O + \text{heat}$$

$$2\,NO + O_2 \rightarrow 2\,NO_2 + \text{heat}$$

$$3\,NO_2 + H_2O \rightarrow 2\,HNO_3 + NO + \text{heat}$$

A simplified flow diagram of the ammonia-oxidation process is

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[21] Ibid., p. 154.

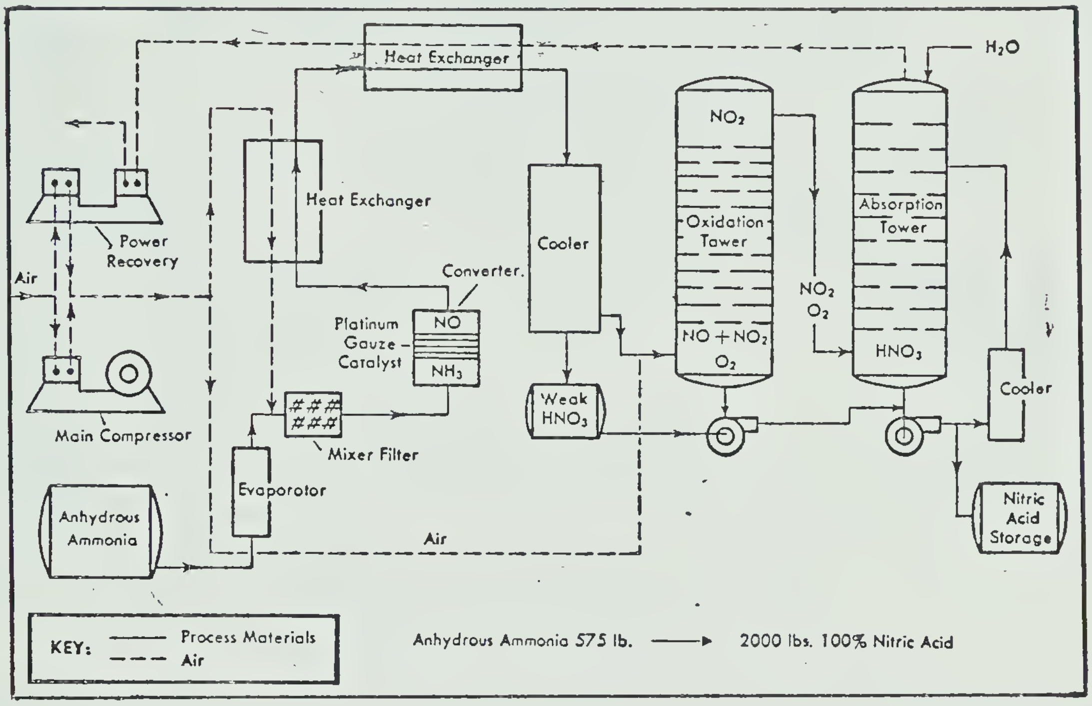
[22] Jacob, Fertilizer Technology, pp. 67-68.

[23] Ibid., p. 67.

shown in Figure B-7. The raw materials needed are anhydrous ammonia, compressed air and distilled water.

FIGURE B-7

Flow Diagram of the Manufacture of Nitric Acid From Anhydrous Ammonia



Source: Jacob, Fertilizer Technology, p. 67.

11: THE MANUFACTURE OF AMMONIUM NITRATE

The reaction taking place in the manufacture of ammonium nitrate may be represented by the following equation:[24]

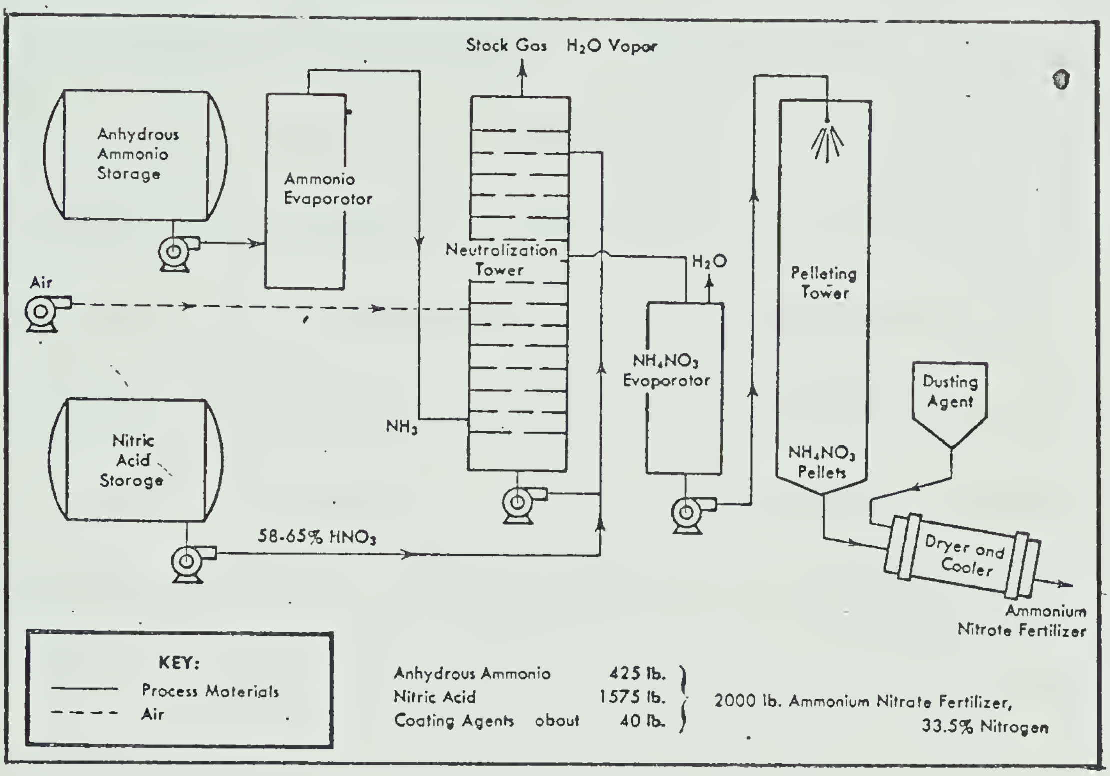
$$HNO_3 + NH_3 \longrightarrow NH_4NO_3 + \text{heat}$$

Ammonium nitrate is made by a continuous process with the aid of a neutralization tower (see Figure B-8).

[24] Ibid., p. 69.

FIGURE B-8

Flow Diagram of the Manufacture of Ammonium Nitrate



Source: Jacob, Fertilizer Technology, p. 70.

Basically in this process, ammonia gas is introduced into the tower near the bottom, while air is added at a higher point. This air cools the solution and carries off excess water vapour. By means of a centrifugal pump, the ammonium nitrate solution is continuously circulated from the bottom of the tower to the top. Nitric acid of 58 to 65 per cent is added to this recirculating line. A solution containing about 80 per cent ammonium nitrate is withdrawn near the middle of the tower. This solution is then treated to form crystals or granules. Large crystals may be formed by careful concentration of the ammonium nitrate solution in a vacuum evaporator with recirculating

features which encourage crystal growth.[25]

Manufacture of granular ammonium nitrate is usually achieved by spray granulation often referred to as the "prilling process". In this process, highly concentrated solution (95 per cent NH_4NO_3) from the evaporator is sprayed from manifolds at the top of a 70 - 90 foot tower against a counter-current of air from the base of the tower. The uprising air causes the solution droplets to solidify into small granules which are dried and cooled in a rotary drier and cylinder respectively. These granules are conveyed to a mixing drum where they are treated with an anti-caking agent, usually diatomaceous earth. The final product contains 33 per cent or more of nitrogen.[26]

12: THE MANUFACTURE OF UREA

Urea is produced by reacting anhydrous ammonia with carbon dioxide under high pressures and temperatures in the presence of a suitable catalyst. The ammonia and carbon dioxide are converted initially into ammonium carbamate according to the following equation:[27]

$$2NH_3 + CO_2 \rightarrow NH_2COONH_4$$

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[25] Ibid., p. 70.

[26] Ibid., p. 70.

[27] Vincent Sauchelli, ed., Fertilizer Nitrogen: Its Chemistry and Technology, American Chemical Society Monograph Series, Vol. CLXI (New York: Reinhold Publishing Corp., 1964), p. 54.

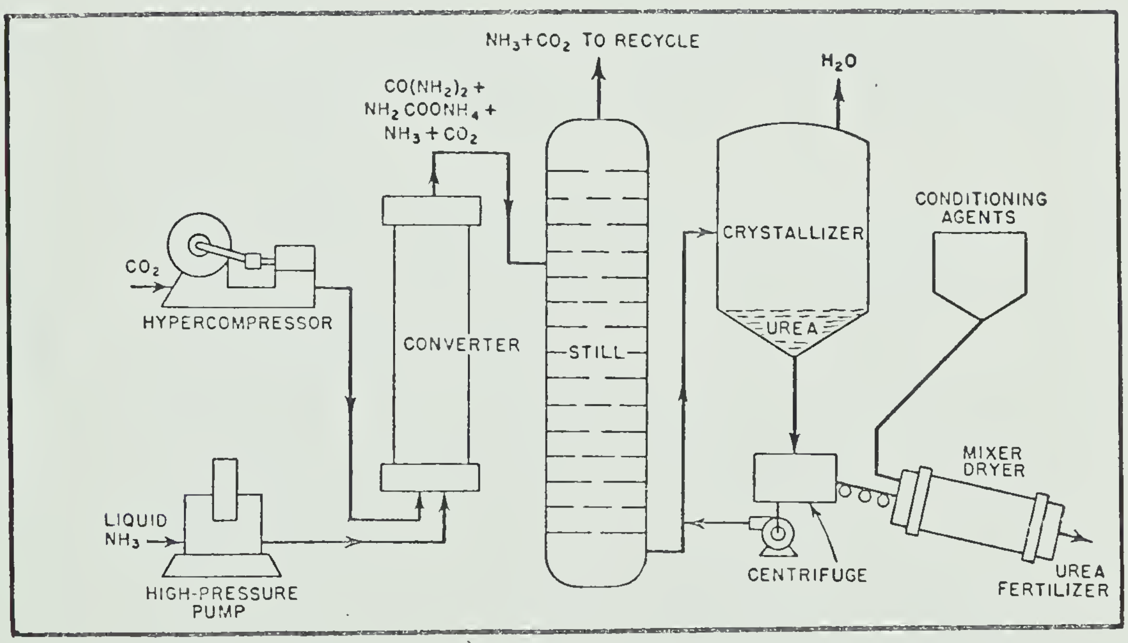
A substantial fraction of the carbamate in the reactor dehydrates to form urea and water as shown in the following equation:

$$NH_2COONH_4 \longrightarrow NH_2CONH_2 + H_2O$$

Figure B-9 shows a flow diagram for the manufacture of a crystalline urea product. The urea-water solution is transformed into a usable form of solid urea by either the crystallization process shown in Figure B-9, or a prilling process, which was described in the manufacture of ammonium nitrate.

FIGURE B-9

Flow Diagram Illustrating the Manufacture of Urea



Source: Tisdale, Soil Fertility, p. 135.

APPENDIX C

WESTERN CANADIAN FERTILIZER CONSUMPTION DATA

APPENDIX C

LIST OF TABLES

TABLE C-1

Total Sales of Fertilizer Materials, Mixed Fertilizers
and Total Fertilizers in Western Canada
Years Ended June 20, 1954-1968

Year	Fertilizer Materials	Mixed Fertilizer	Total
	(short tons)	(short tons)	(short tons)
1954	88,848	16,687	105,535
1955	68,730	16,958	85,688
1956	75,882	16,498	92,380
1957	87,137	17,699	104,836
1958	97,810	18,000	115,810
1959	127,433	19,170	146,603
1960	151,212	19,670	170,882
1961	187,166	19,510	206,676
1962	230,086	23,008	253,094
1963	310,034	23,102	333,136
1964	423,158	25,217	448,375
1965	483,852	27,433	511,285
1966	707,756	31,959	739,715
1967	868,886	30,852	899,738
1968	971,683	36,582	1,008,265

Source: Tables C-6 and C-7, Appendix C.

TABLE C-2

Total Nitrogen, Phosphoric Acid and Potash Contained in Fertilizers Sold in Western Canada During the Years Ended June 30, 1954-1968

Year	Total Fertilizers Sold	Contained		
		Nitrogen (N)	Phosphoric Acid (P_2O_5)	Potash (K_2O)
	(short tons)			
1954	105,535	12,290	35,345	2,073
1955	85,688	10,317	26,229	2,139
1956	92,380	11,985	27,268	2,170
1957	104,836	14,608	30,265	2,209
1958	115,810	16,365	33,271	2,109
1959	146,603	21,352	42,976	2,297
1960	170,882	25,641	49,557	2,388
1961	206,676	32,152	59,923	2,174
1962	253,094	38,590	74,069	3,021
1963	333,136	53,637	96,974	2,987
1964	448,375	75,530	126,918	3,252
1965	511,285	90,691	142,227	3,787
1966	739,715	135,765	198,168	5,289
1967	899,738	180,804	225,639	6,363
1968	1,008,265	210,729	259,015	7,821

Source: Tables C-3, C-4 and C-5, Appendix C.

TABLE C-3

Total Nitrogen Contained in Fertilizer Materials and Mixed Fertilizers Sold in Western Canada; By Province Years Ended June 30, 1954-1968
(short tons)

	Manitoba		Saskatchewan		Alberta		British Columbia		Total Western Canada	
	Nitrogen Contained in		Nitrogen Contained in		Nitrogen Contained in		Nitrogen Contained in		Nitrogen Contained in	
	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed
1954	2,635	33	2,829	5	3,761	11	2,137	879	11,362	928
1955	1,730	38	1,969	5	3,402	9	2,266	898	9,367	950
1956	1,951	55	2,376	5	4,496	12	2,172	918	10,995	990
1957	2,121	61	3,031	7	6,251	16	2,067	1,054	13,470	1,138
1958	2,293	65	2,893	6	7,810	31	2,171	1,096	15,167	1,198
1959	3,005	75	3,673	11	10,873	47	2,425	1,243	19,976	1,376
1960	3,259	93	4,671	15	13,561	78	2,634	1,330	24,125	1,516
1961	4,635	146	5,370	16	17,756	92	2,769	1,368	30,530	1,622
1962	5,152	248	6,213	15	21,451	85	3,764	1,662	36,580	2,010
1963	7,423	179	9,678	29	30,314	124	4,175	1,715	51,590	2,047
1964	9,979	316	17,157	47	41,645	127	4,455	1,804	73,236	2,294
1965	15,361	304	20,678	40	47,684	134	4,466	2,024	88,189	2,502
1966	29,042	458	34,290	50	63,947	185	5,482	2,311	132,761	3,004
1967	37,797	474	48,038	111	86,074	301	5,923	2,086	177,832	2,972
1968	56,938	474	44,505	129	100,304	496	5,415	2,468	207,162	3,567

Note: 1965 figures are not comparable to prior years because of a change in application of per cent used in calculating "N" content solution.

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-4

Total Phosphoric Acid Contained in Fertilizer Materials and Mixed Fertilizers
Sold in Western Canada; By Province Years Ended June 30, 1954-1968
(short tons)

	Manitoba		Saskatchewan		Alberta		British Columbia		Total Western Canada	
	P_2O_5 Contained in		P_2O_5 Contained in		P_2O_5 Contained in		P_2O_5 Contained in		P_2O_5 Contained in	
	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed
1954	8,897	89	11,171	9	11,257	21	1,832	2,069	33,157	2,188
1955	5,805	99	7,075	9	9,243	22	1,826	2,150	23,949	2,280
1956	5,757	149	7,492	11	9,984	33	1,674	2,168	24,907	2,361
1957	5,462	167	8,165	20	12,357	40	1,749	2,305	27,733	2,532
1958	5,507	174	8,645	14	14,837	81	1,699	2,314	30,688	2,583
1959	7,206	200	11,207	23	19,591	130	2,108	2,511	40,112	2,864
1960	7,540	155	13,982	18	22,965	193	2,128	2,576	46,615	2,942
1961	9,576	229	15,784	24	29,160	222	2,415	2,513	56,935	2,988
1962	11,496	337	20,099	28	35,715	191	3,254	2,949	70,564	3,505
1963	14,986	316	29,369	54	45,566	250	3,480	2,953	93,401	3,573
1964	17,555	440	45,754	90	56,021	262	3,702	3,094	123,032	3,886
1965	20,309	442	51,092	87	63,032	277	3,712	3,276	138,145	4,082
1966	41,050	583	75,626	112	72,105	346	4,540	3,806	193,321	4,847
1967	44,483	927	86,090	264	85,383	676	4,737	3,079	220,693	4,946
1968	56,938	853	96,594	303	95,005	1,138	4,536	3,648	253,073	5,942

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-5

Total Potash (K_2O) Contained in Fertilizer Materials and Mixed Fertilizers Sold in Western Canada; By Province Years Ended June 30, 1954-1968 (short tons)

	Manitoba		Saskatchewan		Alberta		British Columbia		Total Western Canada	
	Potash K_2O Contained in		Potash K_2O Contained in		Potash K_2O Contained in		Potash K_2O Contained in		Potash K_2O Contained in	
	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed	Materials	Mixed
1954	4	35	-	4	-	9	471	1,550	475	1,598
1955	10	37	2	4	14	8	485	1,579	511	1,628
1956	6	51	1	5	4	11	555	1,537	566	1,604
1957	3	57	2	6	18	15	475	1,633	498	1,711
1958	6	62	2	5	23	27	352	1,632	383	1,726
1959	4	70	-	9	4	48	450	1,712	458	1,839
1960	2	70	2	10	18	74	494	1,718	516	1,872
1961	2	101	-	12	-	84	358	1,617	360	1,814
1962	1	158	2	11	33	75	838	1,903	874	2,147
1963	37	134	4	27	34	107	771	1,873	846	2,141
1964	103	206	19	42	23	109	788	1,962	933	2,319
1965	46	237	163	35	54	130	1,010	2,112	1,273	2,514
1966	417	339	230	48	123	176	1,499	2,466	2,269	3,029
1967	676	568	301	142	492	331	1,772	2,081	3,241	3,122
1968	1,134	427	530	162	953	560	1,555	2,500	4,172	3,649

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-6

Total Sales of Fertilizer Materials in Western Canada; By Province
Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Increase
	(short tons)					%
1954	21,593	24,556	28,284	14,415	88,848	
1955	14,118	15,874	24,208	14,530	68,730	22.6
1956	14,780	17,900	29,157	14,045	75,882	10.4
1957	14,910	20,708	38,165	13,354	87,137	14.8
.1958	15,478	21,355	47,644	13,333	97,810	12.2
1959	20,204	27,473	64,710	15,046	127,433	30.3
1960	21,607	34,766	79,122	15,717	151,212	18.7
1961	28,684	39,292	103,224	15,966	187,166	23.8
1962	33,073	47,750	126,064	23,199	230,086	22.9
1963	45,608	71,951	169,273	23,202	310,034	34.7
1964	57,229	118,890	223,016	24,023	423,158	36.5
1965	71,764	136,846	250,859	24,383	483,852	26.7
1966	149,427	214,241	314,403	29,685	707,756	46.3
1967	176,835	264,613	396,024	31,414	868,886	22.8
1968	238,352	266,745	437,932	28,654	971,683	11.8

Source: Tables C-8 to C-11, Appendix C.

TABLE C-7

Total Sales of Mixed Fertilizers in Western Canada; By Province
Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Increase
	(short tons)					%
1954	470	83	136	15,998	16,687	
1955	498	77	105	16,278	16,958	1.6
1956	680	68	126	15,624	16,498	- 2.7
1957	754	77	172	16,696	17,699	7.3
1958	811	81	308	16,800	18,000	1.7
1959	890	159	475	17,646	19,170	6.5
1960	857	135	756	17,922	19,670	2.6
1961	1,246	161	873	17,230	19,510	- .8
1962	1,986	130	801	20,091	23,008	17.9
1963	1,517	311	1,174	20,100	23,102	0.4
1964	2,620	450	1,166	20,981	25,217	8.9
1965	2,668	398	1,329	23,038	27,433	9.0
1966	3,957	470	1,713	25,819	31,959	16.5
1967	4,301	1,234	2,917	22,400	30,852	3.5
1968	3,910	1,426	4,954	26,292	36,582	18.6

Source: Tables C-8 to C-11, Appendix C.

TABLE C-8

Sales of Fertilizers in Manitoba
Years Ended June 30, 1954-1968

	Fertilizer Materials		Mixed Fertilizers		Total	
	Sales	Percentage Change	Sales	Percentage Change	Sales	Percentage Change
	tons	%	tons	%	tons	%
1954	21,593		470		22,063	
1955	14,118	- 34.7	498	6.0	14,616	- 33.8
1956	14,780	4.7	680	36.5	15,460	5.8
1957	14,910	0.9	754	10.9	15,664	1.3
1958	15,478	3.8	811	7.6	16,289	4.0
1959	20,204	30.5	890	9.7	21,094	29.5
1960	21,607	6.9	857	- 3.7	22,464	6.5
1961	28,684	32.8	1,246	45.4	29,930	33.2
1962	33,073	15.3	1,986	59.4	35,059	17.1
1963	45,608	37.9	1,517	- 23.6	47,125	34.4
1964	57,229	25.5	2,620	72.7	59,849	27.0
1965	71,764	25.4	2,668	1.8	74,432	24.4
1966	149,427	108.2	3,957	48.3	153,384	106.1
1967	176,835	18.3	4,301	8.7	181,136	18.1
1968	238,352	34.8	3,910	- 9.1	242,262	33.7

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-9

Sales of Fertilizers in Saskatchewan
Years Ended June 30, 1954-1968

	Fertilizer Materials		Mixed Fertilizers		Total	
	Sales	Percentage Change	Sales	Percentage Change	Sales	Percentage Change
	tons	%	tons	%	tons	%
1954	24,556		83		24,639	
1955	15,874	-35.4	77	- 7.2	15,951	-35.3
1956	17,900	12.8	68	- 13.2	17,968	12.6
1957	20,708	15.7	77	13.2	20,785	15.7
1958	21,355	3.1	81	5.2	21,436	3.1
1959	27,473	28.6	159	96.3	27,632	28.9
1960	34,766	26.5	135	- 15.1	34,901	26.3
1961	39,292	13.0	161	19.3	39,453	13.0
1962	47,750	21.5	130	- 19.3	47,880	21.4
1963	71,951	50.7	311	139.2	72,262	50.9
1964	118,890	65.2	450	44.7	119,340	65.1
1965	136,846	15.1	398	- 11.6	137,244	15.0
1966	214,241	56.5	470	18.1	214,711	56.4
1967	264,613	23.5	1,234	162.5	265,847	23.8
1968	266,745	0.8	1,426	15.7	268,171	0.9

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-10

Sales of Fertilizers in Alberta
Years Ended June 30, 1954-1968

	Fertilizer Materials		Mixed Fertilizers		Total	
	Sales	Percentage Change	Sales	Percentage Change	Sales	Percentage Change
	tons	%	tons	%	tons	%
1954	28,284		136		28,420	
1955	24,208	-14.4	105	-22.8	24,313	-14.5
1956	29,157	20.4	126	20.0	29,283	20.4
1957	38,165	30.9	172	35.5	38,337	30.9
1958	47,644	24.8	308	79.1	47,952	25.1
1959	64,710	35.8	475	54.2	65,185	35.9
1960	79,122	22.3	756	59.2	79,878	22.5
1961	103,224	30.5	873	15.5	104,097	30.3
1962	126,064	22.1	801	- 8.2	126,865	21.9
1963	169,273	34.3	1,174	46.6	170,447	34.4
1964	223,016	31.7	1,166	- 0.7	224,182	31.5
1965	250,859	12.5	1,329	14.0	252,188	12.5
1966	314,403	25.3	1,713	28.9	316,116	25.3
1967	396,024	26.0	2,917	70.3	398,941	26.2
1968	437,932	10.6	4,954	69.8	442,886	11.0

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-11

Sales of Fertilizers in British Columbia
Years Ended June 30, 1954-1968

	Fertilizer Materials		Mixed Fertilizers		Total	
	Sales	Percentage Change	Sales	Percentage Change	Sales	Percentage Change
	tons	%	tons	%	tons	%
1954	14,415		15,998		30,413	
1955	14,530	0.1	16,278	1.8	30,808	1.3
1956	14,045	- 3.4	15,624	- 4.2	29,669	- 3.8
1957	13,354	- 4.9	16,696	6.9	30,050	1.3
1958	13,333	- 0.2	16,800	0.6	30,133	9.3
1959	15,046	12.8	17,646	5.0	32,692	8.5
1960	15,717	4.4	17,922	1.6	33,639	2.9
1961	15,966	1.6	17,230	- 3.9	33,196	- 1.3
1962	23,199	45.3	20,091	16.7	43,290	30.4
1963	23,202	-	20,100	-	43,302	-
1964	24,023	3.5	20,981	4.4	45,004	3.9
1965	24,383	1.5	23,038	9.8	47,421	5.4
1966	29,685	21.7	25,819	12.1	55,504	17.0
1967	31,414	5.8	22,400	13.2	53,814	3.0
1968	28,654	- 8.8	26,292	17.4	54,946	2.1

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-12

Sales of Ammonium Nitrate in Western Canada; By Province
Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Increase
			(short tons)			%
1954	52	135	1,782	2,753	4,722	
1955	75	174	1,968	3,293	5,510	16.7
1956	185	457	2,512	2,810	5,964	8.2
1957	314	1,299	4,110	2,665	8,388	40.6
1958	423	1,028	5,410	2,912	9,773	16.5
1959	824	1,062	7,929	3,325	13,140	34.5
1960	1,031	1,475	11,265	3,722	17,493	33.1
1961	2,038	1,804	14,220	3,578	21,640	23.7
1962	1,414	1,464	15,827	4,658	23,363	8.0
1963	2,430	2,531	24,228	5,124	34,313	46.7
1964	3,959	5,148	34,758	5,066	48,931	42.6
1965	6,213	4,905	40,609	5,134	56,861	16.1
1966	21,335	10,501	55,503	5,854	93,193	63.9
1967	34,255	13,764	71,625	7,011	126,655	35.9
1968	51,775	9,531	79,051	5,426	145,783	15.1

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-13

Sales of Ammonium Nitrate Phosphate in Western Canada; By Province
Years Ended June 30, 1962-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1962	5,539	2,670	8,210	1,828	18,247	
1963	8,779	5,047	14,333	2,737	30,896	69.3
1964	13,282	13,050	20,415	3,764	50,511	63.5
1965	15,443	22,756	30,509	3,364	72,072	42.7
1966*	24,298	30,343	24,170	1,286	138,381	92.0
1966**	14,543	17,690	23,969	2,082		
1967*	41,086	85,579	45,071	1,623	229,939	66.2
1967**	14,338	8,680	27,074	1,826		
1968*	53,057	78,532	51,670	2,235	245,512	6.8
1968**	16,776	2,836	21,660	1,903		

Notes:
(1) Prior to 1962 Ammonium Nitrate Phosphate type fertilizers were included in the category "Other fertilizer materials.".
(2) * denotes sales of 23-23-0
** denotes sales of 27-14-0
(3) The sales figures of 23-23-0 and 27-14-0 are combined in "Total Western Canada" to facilitate percentage calculations.
(4) The 1968 Total for Western Canada has an additional 16,843 tons of Ammonium Nitrate which was not specified as to type.

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1962-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1962-1968).

TABLE C-14

Sales of Ammonium Phosphate 11-48-0 in Western Canada; By Province
Years Ending June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1954	16,450	22,483	21,774	1,064	61,771	
1955	10,778	14,219	17,865	1,084	43,946	-28.8
1956	10,307	14,625	18,272	942	44,146	0.4
1957	9,362	15,756	21,616	1,022	47,756	8.2
1958	9,485	16,787	25,454	1,168	52,894	10.7
1959	12,368	21,559	32,487	1,751	68,165	28.9
1960	12,817	26,847	37,420	1,585	78,669	15.4
1961	15,587	30,044	46,432	2,182	94,245	19.8
1962	18,559	39,090	54,648	2,413	114,710	21.7
1963	23,292	56,304	67,550	2,771	149,917	30.7
1964	24,905	84,735	80,661	2,529	192,830	28.6
1965	30,360	91,737	90,680	2,644	215,421	11.7
1956	59,566	127,374	102,041	3,380	292,361	35.7
1967	56,570	126,298	116,407	4,307	303,582	3.8
1968	50,242	128,468	116,902	3,284	298,896	- 1.6

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-15

Sales of Ammonium Phosphate 16-20-0 in Western Canada; By Province
Years Ended June 30, 1954 - 1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
			(short tons)			%
1954	4,973	1,897	3,980	3,356	14,206	
1955	3,136	1,180	3,195	3,295	10,806	-23.9
1956	3,916	2,185	5,533	3,002	14,636	35.4
1957	4,286	2,427	8,509	2,543	17,765	21.4
1958	4,146	2,428	11,685	2,903	21,162	19.1
1959	5,012	3,186	16,953	3,558	28,709	35.7
1960	5,217	3,726	21,188	3,511	33,642	17.2
1961	6,109	4,411	28,975	3,747	43,242	28.5
1962	6,809	4,049	38,616	5,527	55,001	27.2
1963	10,178	7,585	49,390	4,799	71,952	30.8
1964	11,997	14,570	65,517	5,546	97,630	35.7
1965	13,056	15,950	67,940	5,652	102,598	5.1
1966	22,793	24,590	68,255	7,382	123,020	19.9
1967	10,536	13,797	63,554	7,364	95,251	22.6
1968	6,739	8,893	56,024	4,822	76,478	-19.8

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-16

Sales of Ammonium Phosphate (Other Grades)[(1)] in Western Canada;

By Province Years Ending June 30, 1963[(2)]-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1963	486	77	1,933	182	2,678	
1964	469	114	1,403	288	2,274	- 15.1
1965	694	76	1,206	230	2,206	- 3.0
1966	254	23	909	355	1,541	- 30.1
1967	6,894	2,955	4,325	250	14,424	187.1
1968	23,573	25,872	21,285	756	71,486	395.6

Notes: (1) Other grades include 16-48-0, 18-46-0, 11-55-0; and other grades not specified
(2) Prior to 1963 there was no listing of "other grades" of ammonium phosphate

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1963-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1963-1968).

TABLE C-17

Sales of Urea, In Western Canada; By Province
Years Ending June 30, 1960-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1960	-	-	-	53	53	
1961	8	2	70	104	184	247.2
1962	8	11	111	173	303	64.7
1963	118	35	688	151	992	227.4
1964	437	324	2,826	295	3,882	291.3
1965	1,323	179	2,595	421	4,518	16.4
1966	3,919	1,508	5,909	601	11,937	164.2
1967	5,545	7,111	13,025	412	26,093	118.6
1968	15,019	4,559	11,747	740	32,065	22.1

Note: Prior to 1960 sales of urea were not reported separately but included in the category "all other materials".

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1960-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1960-1968).

TABLE C-18

Sales of Ammonium Sulphate in Western Canada; By Province
Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
			(short tons)			%
1954	26	40	700	2,302	3,068	
1955	89	62	803	2,147	3,101	1.1
1956	110	181	1,772	2,683	4,746	53.0
1957	122	98	1,525	1,802	3,547	-25.3
1958	79	77	2,196	1,774	4,126	16.3
1959	75	149	2,933	1,766	4,923	19.3
1960	86	156	3,608	2,032	5,882	19.5
1961	141	228	6,905	1,968	9,242	57.1
1962	160	246	7,346	2,039	9,791	5.9
1963	232	349	10,238	2,120	12,939	32.2
1964	574	758	16,215	1,842	19,389	49.8
1965	690	466	15,807	1,960	18,923	- 2.4
1966	574	878	20,154	1,991	23,597	24.7
1967	1,337	727	23,326	2,367	27,757	17.6
1968	3,231	669	24,970	2,669	31,539	13.6

Notes: Prior to 1963 ammonium sulphate was referred to as "sulphate of ammonia."

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-19

Sales of Anhydrous Ammonia in Western Canada; By Province
Years Ended June 30, 1956-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1956	84	199	241	25	549	
1957	116	286	426	50	878	59.9
1958	148	52	314	25	539	- 38.6
1959	92	16	426	25	559	3.7
1960	52	-	368	3	423	- 24.3
1961	64	-	405	3	472	11.6
1962	26	-	252	-	278	- 41.1
1963	26	15	660	-	701	152.1
1964	26	110	965	-	1,101	57.1
1965	3,836	450	1,398	-	5,684	416.2
1966	-	-	378	-	378	- 93.3
1967	-	78	934	-	1,012	167.7
1968	231	69	8,636	-	8,936	783.0

Note: Prior to 1956 Anhydrous Ammonia was included in the category "Other Fertilizer Materials."

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1956-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1956-1968).

TABLE C-20

Sales of Potassium Chloride (Muriate of Potash) in Western Canada;
By Province Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1954	5	-	-	603	608	
1955	12	3	19	688	722	18.7
1956	9	-	6	794	809	12.0
1957	4	1	5	693	703	- 13.1
1958	8	2	38	438	486	- 30.9
1959	6	-	4	511	521	6.4
1960	3	4	29	562	598	14.8
1961	4	-	-	343	347	- 42.0
1962	1	4	54	1,058	1,117	221.9
1963	62	6	56	930	1,054	- 5.6
1964	165	31	37	932	1,165	10.5
1965	72	265	89	1,322	1,748	50.0
1966	571	333	90	2,116	3,110	77.9
1967	1,063	493	806	2,470	4,832	55.4
1968	1,592	883	1,568	2,253	6,296	30.3

Notes: Prior to 1962 Potassium Chloride was referred to as Muriate of Potash 60%.

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-21

Sales of Normal Superphosphate (22% of less P_2O_5) in Western Canada;
By Province Years Ending June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1954	1	-	15	1,786	1,802	
1955	-	-	10	1,906	1,916	6.3
1956	1	-	45	1,460	1,506	51.7
1957	-	-	15	1,743	1,758	16.7
1958	-	-	14	1,272	1,286	-26.8
1959	-	-	10	1,020	1,030	-19.9
1960	1	-	12	1,050	1,063	3.2
1961	-	16	1	596	613	-42.3
1962	-	-	2	1,177	1,179	92.3
1963	-	2	-	1,051	1,053	-10.8
1964	-	-	-	962	962	- 8.6
1965	1	-	-	1,124	1,125	16.9
1966	-	2	-	821	823	26.8
1967	-	-	-	507	507	-38.4
1968	-	-	-	866	866	70.8

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-22

Sales of Triple Superphosphate (more than 22% P_2O_5) in Western Canada; By Province Years Ending June 30, 1965-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
			(short tons)			%
1954	-	-	-	65	65	
1955	-	-	-	93	93	43.1
1956	-	-	-	139	139	49.5
1957	-	-	-	148	148	6.5
1958	-	1	-	160	161	8.8
1959	-	-	-	289	289	79.5
1960	-	4	3	507	514	77.8
1961	20	-	55	330	405	-21.2
1962	1	25	24	648	698	72.3
1963	-	-	-	556	556	-20.3
1964	46	-	-	571	617	11.0
1965	2	-	-	644	646	4.7
1966	-	-	-	401	401	-37.9
1967	-	-	-	642	642	60.2
1968	-	-	-	698	698	8.7

Notes: Prior to 1962 Superphosphate was referred to as "triple superphosphate" 45% P_2O_5. Since 1962 superphosphate is referred to as "Superphosphate more than 22% P_2O_5."

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

TABLE C-23

Sales of Calcium Cyanamide (fertilizer grade) in Western Canada;
By Province Years Ended June 30, 1954-1968

Year	Manitoba	Sask-atchewan	Alberta	British Columbia	Total Western Canada	Percentage Change
	(short tons)					%
1954	28	1	1	146	176	
1955	-	-	-	188	188	6.8
1956	-	-	-	165	165	- 12.2
1957	-	-	-	185	185	12.1
1958	-	-	-	172	172	- 7.0
1959	-	-	-	88	88	- 48.8
1960	-	-	-	69	69	- 21.6
1961	-	-	-	90	90	30.4
1962	-	-	-	87	87	- 3.3
1963	2	-	-	255	257	195.4
1964	-	-	1	171	172	- 33.1
1965	-	-	5	126	131	- 23.8
1966	-	-	-	47	47	- 64.1
1967	-	-	-	30	30	- 36.2
1968	-	-	-	46	46	53.3

Source: Canada, Dominion Bureau of Statistics, Fertilizer Trade, Summary of Annual Reports 1954-1968, Catalogue No. 46-207 (Ottawa: Queen's Printer, 1954-1968).

APPENDIX D

WESTERN UNITED STATES FERTILIZER CONSUMPTION DATA

APPENDIX D

LIST OF TABLES

TABLE D-1

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Arizona 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	21,462	112,898	20,841	155,201	32,495	12,338	956
1955	20,949	131,330	19,656	171,935	34,498	13,738	1,191
1956	16,612	126,389	10,563	153,564	35,997	13,677	1,266
1957	24,636	143,116	10,351	178,103	41,794	15,520	1,539
1958	32,566	155,886	20,484	208,936	48,440	20,160	1,831
1959	29,236	150,100	16,643	195,979	49,438	19,261	1,837
1960	34,844	136,948	13,814	185,606	45,539	21,552	2,038
1961	32,065	161,009	15,081	208,155	55,242	20,992	2,273
1962	31,048	160,628	21,764	213,440	57,723	19,969	1,515
1963	36,114	169,133	28,108	233,355	61,420	23,895	1,633
1964	34,156	175,474	29,771	239,401	63,806	24,511	1,484
1965	30,846	171,964	31,931	234,741	64,380	24,029	1,282
1966	33,736	173,902	22,582	230,220	71,909	24,239	1,246
1967	35,014	191,454	15,385	241,853	81,518	25,335	1,124
1968*	37,845	192,281	13,005	243,131	84,463	28,929	1,082

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-2

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of California 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	221,264	867,874	436,828	1,525,966	172,965	65,715	20,300
1955	240,261	957,867	635,685	1,833,813	188,630	69,967	22,651
1956	246,494	1,038,413	628,696	1,913,603	208,378	77,909	23,345
1957	281,746	1,085,875	760,517	2,128,138	223,268	80,356	26,790
1958	302,322	1,118,638	752,602	2,173,562	238,586	85,920	30,856
1959	334,673	1,223,945	1,030,645	2,589,263	266,352	94,067	33,110
1960	336,934	1,233,860	1,197,247	2,768,041	268,487	105,194	36,078
1961	355,168	1,250,762	1,015,490	2,621,420	283,085	105,303	30,141
1962	367,939	1,242,837	1,064,584	2,675,360	290,160	106,099	31,612
1963	377,052	1,348,373	1,227,428	2,952,853	314,105	107,846	35,443
1964	427,740	1,473,513	1,237,369	3,138,622	345,741	120,238	32,007
1965	477,404	1,495,827	1,267,695	3,240,926	360,335	136,506	31,268
1966	429,665	1,489,950	1,216,295	3,135,910	357,917	123,507	34,856
1967	523,612	1,507,073	1,148,874	3,179,559	382,094	142,226	50,758
1968*	575,973	1,606,391	1,333,369	3,515,733	407,668	151,551	55,046

* 1968 figures are preliminary

Source: U. S. Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-3

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Colorado 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nut rients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	14,690	31,785	1,299	47,774	7,005	11,719	680
1955	13,453	34,701	578	48,732	7,468	11,144	899
1956	12,041	41,323	186	53,550	9,375	11,329	1,166
1957	10,725	47,954	498	59,177	11,533	12,509	1,237
1958	13,643	65,037	2,909	81,589	18,235	14,350	1,415
1959	14,196	71,572	3,290	89,058	20,202	15,344	1,505
1960	18,933	75,909	1,418	96,260	23,510	17,477	1,596
1961	21,489	106,051	2,001	129,541	23,732	21,500	2,099
1962	25,461	121,297	1,594	148,352	31,468	22,666	2,085
1963	35,790	110,374	1,042	147,206	29,458	24,664	2,620
1964	39,770	125,530	660	165,960	38,672	27,046	2,870
1965	54,425	128,434	5,122	187,981	39,097	32,267	3,102
1966	57,530	136,658	2,613	196,801	50,984	31,134	3,773
1967	71,575	153,365	1,286	226,226	58,453	36,994	5,499
1968*	79,861	168,716	2,611	251,188	69,207	40,445	7,209

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-4

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Idaho 1954-1968

	Kinds of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	6,786	77,670	5,538	89,994	12,494	14,996	191
1955	5,422	96,636	4,355	106,413	19,129	12,072	182
1956	4,777	53,438	6,204	64,419	11,081	10,602	223
1957	7,982	67,845	9,566	85,393	14,392	12,872	348
1958	8,201	93,253	6,579	108,033	21,987	13,985	821
1959	13,574	112,805	8,473	134,852	25,933	18,711	621
1960	19,073	118,541	11,899	149,513	28,785	24,441	298
1961	34,279	140,127	5,612	180,018	37,345	27,885	941
1962	32,188	129,545	12,566	174,299	36,578	23,475	756
1963	29,432	141,315	9,331	180,078	39,529	24,053	789
1964	42,495	182,177	9,379	234,051	49,807	35,396	1,518
1965	50,615	191,994	11,500	254,109	54,720	36,444	1,080
1966	45,647	228,241	12,153	286,041	58,690	41,018	2,117
1967	50,609	240,894	13,747	305,250	64,550	43,819	4,009
1968*	55,432	261,057	10,109	326,598	72,896	46,405	4,236

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-5

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Iowa 1954-1968

	Kinds of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	420, 864	231, 222	72	652, 158	76, 119	102, 398	45, 525
1955	368, 178	216, 799	75	585, 052	69, 707	100, 003	49, 789
1956	305, 843	143, 351	112	449, 306	43, 917	81, 143	44, 838
1957	307, 461	157, 714	3, 037	468, 212	50, 484	80, 809	46, 593
1958	339, 597	202, 417	78	542, 092	65, 391	92, 835	52, 002
1959	434, 635	260, 850	34	695, 519	93, 739	117, 532	66, 595
1960	439, 953	250, 200	539	690, 692	103, 117	115, 070	64, 837
1961	469, 411	319, 531	1, 465	790, 407	133, 816	124, 559	65, 842
1962	483, 041	388, 537	1, 113	872, 691	164, 366	137, 970	72, 697
1963	563, 509	537, 918	1, 869	1, 103, 296	229, 696	169, 921	94, 893
1964	598, 324	689, 216	5, 441	1, 292, 981	273, 189	206, 817	122, 391
1965	654, 647	771, 566	4, 855	1, 431, 068	316, 444	225, 471	139, 397
1966	773, 335	977, 207	1, 648	1, 752, 190	398, 257	280, 029	178, 177
1967	1, 001, 093	1, 277, 612	2, 482	2, 281, 187	543, 471	348, 174	268, 162
1968*	964, 030	1, 463, 280	2, 150	2, 429, 460	636, 250	345, 656	282, 308

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-6

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Arizona 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	251,544	70,907	324	322,775	24,202	64,881	37,556
1955	278,435	93,962	274	372,671	34,959	78,244	43,784
1956	289,323	76,631	2,154	368,108	32,347	80,173	48,273
1957	326,091	99,714	342	426,147	38,266	93,972	54,980
1958	320,211	123,031	64	443,306	49,448	93,178	55,017
1959	395,249	153,170	98	548,517	63,610	108,762	70,722
1960	393,162	145,067	221	538,450	54,022	114,365	68,298
1961	407,967	150,228	31	558,226	65,027	115,909	71,939
1962	399,300	160,911	61	560,272	66,340	115,128	74,711
1963	427,814	188,883	1,258	617,955	85,552	124,183	83,079
1964	530,015	201,852	1,251	733,118	94,245	166,158	102,842
1965	540,175	257,481	1,435	799,091	103,595	186,816	106,418
1966	546,245	304,643	885	851,773	114,479	196,785	114,902
1967	631,200	478,410	1,875	1,111,485	188,123	211,695	174,551
1968*	626,002	612,049	1,720	1,239,771	253,499	210,594	196,627

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-7

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Montana 1954-1968

	Kind of Fertilizer				Primary Nutrients Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	4,234	24,184	684	29,102	3,141	8,027	49
1955	3,008	20,253	425	23,686	2,201	7,275	52
1956	3,657	28,122	1,189	32,968	3,523	9,304	74
1957	3,907	39,596	417	43,920	5,909	12,176	78
1958	4,444	33,327	443	38,214	4,458	11,964	93
1959	3,159	37,608	469	41,236	5,085	12,741	164
1960	3,998	40,302	428	44,728	6,319	13,537	98
1961	5,417	45,801	1,124	52,342	8,282	14,988	215
1962	5,883	44,125	804	50,812	7,401	14,406	81
1963	12,412	52,183	543	65,138	9,171	19,858	303
1964	18,299	50,145	708	69,152	9,533	21,477	255
1965	22,242	52,129	711	75,082	10,932	22,499	413
1966	30,244	71,445	852	102,541	17,499	26,609	449
1967	40,104	100,574	482	141,160	25,002	37,146	1,115
1968*	51,333	116,617	550	168,500	30,852	43,517	1,534

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-8

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Nebraska 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	65,946	132,584	586	199,116	52,696	25,172	1,698
1955	47,992	159,833	388	208,213	55,794	26,719	1,450
1956	20,510	112,416	64	132,990	49,072	16,139	939
1957	24,719	144,971	42	169,732	63,016	21,500	1,303
1958	31,742	200,235	76	232,053	94,154	19,800	1,520
1959	46,361	258,540	161	305,062	121,063	25,415	2,113
1960	49,675	272,011	248	321,934	125,436	26,563	2,033
1961	76,341	415,728	483	492,552	195,259	39,576	3,327
1962	78,861	386,128	214	465,203	180,932	44,597	3,380
1963	111,709	416,431	912	529,052	208,200	52,967	4,937
1964	113,144	409,874	1,441	524,459	209,815	54,811	6,686
1965	137,514	444,370	1,310	583,194	230,337	58,719	8,657
1966	186,118	564,859	2,308	753,285	302,033	79,950	12,261
1967	240,380	635,101	2,936	878,417	328,216	106,014	22,772
1968*	230,765	770,562	3,050	1,004,377	404,830	106,398	28,557

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-9

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Nevada 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	873	2,541	5,741	9,155	414	546	40
1955	686	1,118	1,377	3,181	3,175	328	23
1956	1,007	2,178	1,097	4,282	404	425	46
1957	1,368	2,977	2,760	7,105	672	455	68
1958	1,884	3,914	15,961	21,759	926	924	74
1959	2,317	3,184	385	55,886	986	783	72
1960	2,022	3,263	300	5,585	1,282	700	92
1961	2,292	4,617	1,149	8,058	1,381	888	87
1962	1,485	5,636	1,325	8,446	1,719	908	58
1963	1,534	6,048	1,531	9,113	1,747	1,108	65
1964	2,061	5,976	4,129	12,166	1,772	1,249	79
1965	3,505	7,226	2,415	13,146	2,165	1,656	72
1966	2,833	7,863	2,164	12,860	2,483	1,531	86
1967	2,974	9,297	2,496	14,767	2,905	1,974	98
1968*	3,141	8,133	4,234	15,508	2,703	1,456	111

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-10

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of North Dakota 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	23,058	24,599	20	47,677	2,924	16,541	1,275
1955	23,686	39,221	103	63,010	4,598	22,329	1,359
1956	23,858	45,309	1	69,168	6,101	24,935	1,446
1957	30,009	51,736	0	81,745	8,458	28,858	1,626
1958	30,954	75,788	0	106,742	12,923	36,483	1,674
1959	39,525	92,309	0	131,834	18,033	43,697	1,519
1960	49,952	94,023	2	143,977	20,456	48,192	1,588
1961	55,953	104,859	4	160,816	23,884	52,226	1,869
1962	52,414	115,628	10	168,052	23,921	56,038	1,539
1963	57,331	101,449	71	158,851	22,459	56,176	1,982
1964	64,454	118,914	262	183,630	24,871	66,059	2,373
1965	78,721	120,217	159	199,097	27,011	69,577	3,288
1966	100,801	145,520	170	246,491	34,803	84,599	4,634
1967	132,617	165,476	94	298,187	44,217	99,732	6,290
1968*	182,935	178,200	105	361,240	62,719	110,980	9,160

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-11

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Oregon 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	21,979	110,723	14,698	147,400	25,640	12,334	3,028
1955	22,295	132,677	17,276	172,248	32,056	13,178	3,108
1956	26,450	127,532	15,961	169,943	31,131	12,811	4,345
1957	29,511	171,674	16,884	218,069	42,203	14,856	3,725
1958	28,171	150,634	13,339	192,144	39,505	12,606	3,551
1959	31,096	158,535	10,698	200,329	41,689	13,887	3,843
1960	29,550	157,680	11,463	198,693	38,103	17,381	4,210
1961	49,658	178,355	12,686	240,699	45,447	19,518	7,213
1962	51,009	181,936	16,771	249,716	47,441	20,169	6,855
1963	46,730	209,985	11,737	268,452	53,963	21,446	7,064
1964	45,077	222,049	18,023	285,149	55,350	22,634	8,251
1965	49,781	257,377	21,864	328,967	62,323	27,291	8,003
1966	55,428	286,085	21,055	362,568	72,558	33,738	10,867
1967	71,679	355,532	14,457	441,668	92,064	47,797	11,553
1968*	71,125	358,942	16,018	446,085	90,412	51,949	11,290

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-12

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of South Dakota 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrients Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	13,399	16,608	0	30,007	4,311	6,579	217
1955	16,138	21,763	0	37,901	5,904	8,559	246
1956	9,421	17,179	0	26,600	4,486	6,451	193
1957	9,730	14,845	0	24,575	3,515	6,534	165
1958	10,665	23,577	1	34,243	6,362	7,607	160
1959	11,269	27,442	2	38,713	7,698	7,548	229
1960	12,526	23,572	0	36,098	7,379	7,260	186
1961	17,422	35,102	0	52,524	11,269	9,603	323
1962	20,651	45,074	0	65,725	14,697	12,469	413
1963	26,848	53,006	86	79,940	18,140	14,140	705
1964	42,342	56,938	104	99,384	22,516	18,471	1,617
1965	49,583	56,184	7	105,774	25,201	16,981	1,815
1966	70,841	88,079	6	158,926	38,678	28,148	3,945
1967	84,309	111,233	0	195,542	47,529	33,030	6,028
1968*	110,992	126,793	12	237,797	59,670	37,927	7,798

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-13

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Utah 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	3,621	24,483	313	28,417	4,580	3,960	134
1955	3,645	23,967	251	27,863	4,899	4,457	159
1956	4,337	26,410	237	30,984	6,017	4,901	186
1957	4,924	27,240	163	32,317	5,194	5,696	224
1958	4,324	35,093	292	39,709	7,592	6,547	238
1959	6,743	30,109	401	37,253	6,914	5,877	242
1960	8,100	34,153	101	42,354	7,470	6,564	270
1961	8,405	36,031	235	44,671	8,146	6,436	259
1962	9,680	32,361	301	42,342	7,455	7,677	292
1963	9,439	27,857	368	37,664	9,753	4,562	336
1964	8,448	37,732	467	46,647	9,623	6,663	245
1965	14,586	45,099	358	60,043	12,301	11,339	351
1966	19,273	60,153	382	79,808	11,998	19,562	343
1967	25,534	50,280	396	76,210	11,907	19,870	242
1968*	27,577	52,806	400	80,783	13,223	21,372	337

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-14

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Washington 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	29,630	125,272	46,369	201,271	36,243	13,704	4,709
1955	35,083	150,002	13,731	198,816	44,135	14,037	5,003
1956	35,954	121,470	12,415	169,839	37,998	13,612	5,640
1957	36,881	132,462	15,232	184,575	43,941	11,696	5,020
1958	45,125	194,580	8,034	247,739	66,329	17,376	6,326
1959	46,375	188,944	7,758	243,077	64,739	17,628	7,068
1960	51,440	216,829	8,217	276,486	75,476	19,667	6,839
1961	55,621	193,110	14,727	263,458	64,198	21,599	5,861
1962	92,258	254,165	25,834	372,257	84,333	29,323	13,255
1963	65,573	297,193	24,227	386,993	99,530	29,389	9,490
1964	72,865	303,664	15,009	391,538	103,047	33,967	9,404
1965	88,247	318,582	14,470	421,299	114,412	32,168	12,016
1966	96,327	349,160	17,767	463,254	118,828	38,049	12,965
1967	100,697	397,285	15,011	512,993	135,106	38,428	17,988
1968*	131,025	424,257	15,384	570,666	143,154	48,625	24,789

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-15

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Wisconsin 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	402,141	38,827	235	441,203	19,736	59,755	71,803
1955	397,158	32,589	256	430,003	20,505	62,152	74,390
1956	379,861	32,320	93	412,274	20,811	62,874	76,174
1957	389,452	36,984	41	426,477	22,448	65,401	81,425
1958	394,985	45,341	146	440,472	26,193	67,289	86,604
1959	420,716	56,791	345	477,852	28,974	70,813	97,946
1960	369,971	52,174	507	422,652	25,550	66,873	88,353
1961	371,879	72,173	185	444,237	30,733	68,490	97,342
1962	349,468	77,888	145	427,501	31,846	66,339	96,464
1963	366,892	89,108	1,576	457,576	35,207	70,596	104,281
1964	394,996	125,519	2,180	522,695	43,794	80,769	121,991
1965	423,317	169,079	1,729	594,125	50,557	90,207	137,866
1966	419,059	210,042	1,966	631,067	60,190	93,555	148,576
1967	459,039	295,646	1,647	756,332	79,252	111,251	179,764
1968*	417,862	412,172	1,062	831,096	110,338	113,053	205,159

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-16

Consumption of All Fertilizer By Major Kind and Consumption of Primary Nutrients in the State of Wyoming 1954-1968

	Kind of Fertilizer				Primary Nutrients		
					Available		
	Mixed Fertilizer	Primary Nutrient Materials	Secondary and Micro-Nutrients	Total Fertilizer	N	P_2O_5	K_2O
	tons	tons	tons	tons	tons	tons	tons
1954	2,379	7,772	1,081	11,232	1,097	3,011	44
1955	2,006	8,358	731	11,095	997	3,405	72
1956	1,839	9,379	661	11,879	1,686	3,414	50
1957	1,268	9,175	0	10,443	2,007	2,863	51
1958	1,370	11,504	0	12,874	2,811	3,020	32
1959	1,478	14,051	402	15,931	3,281	3,592	60
1960	1,125	16,670	384	18,179	3,773	4,321	30
1961	1,153	13,326	0	14,479	3,542	3,396	32
1962	1,150	14,404	11	15,565	3,599	3,652	39
1963	3,534	18,385	5	21,924	5,586	4,728	87
1964	5,854	19,311	6	25,171	5,719	5,310	87
1965	6,788	24,177	5	30,970	7,678	5,732	50
1966	12,353	30,734	173	43,260	10,388	8,007	252
1967	15,071	35,204	12	50,287	12,104	8,870	421
1968*	16,690	36,339	15	53,044	12,940	8,737	582

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-17

Consumption of Selected Nitrogen Materials by Direct Application
In the State of Arizona 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	9,042	7,531	13,490	25,037	6,299	9,458
1955	9,941	7,517	11,401	28,909	6,636	9,914
1956	14,427	6,240	8,063	23,174	4,753	10,604
1957	16,321	6,511	6,816	29,853	4,116	14,598
1958	21,201	10,217	8,295	30,168	3,126	12,691
1959	25,014	9,600	10,589	22,149	6,425	12,097
1960	23,147	8,277	6,759	14,314	4,551	12,701
1961	28,969	11,709	8,387	16,114	10,984	19,873
1962	29,155	12,943	8,184	14,257	13,415	22,208
1963	29,957	13,964	6,658	18,298	18,010	23,474
1964	30,515	13,290	8,760	15,295	19,441	26,697
1965	33,315	10,095	8,085	14,521	20,869	25,902
1966	36,459	2,404	2,734	3,052	5,577	11,174
1967	54,072	11,068	7,696	17,372	18,977	25,697
1968*	57,883	9,960	7,522	12,900	16,289	27,375

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-18

Consumption of Selected Nitrogen Materials by Direct Application
In the State of California 1954 - 1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	45,932	75,681	71,079	172,230	16,517	19,665
1955	51,518	51,518	57,135	163,025	118,081	15,844
1956	68,412	201,167	52,179	140,934	15,690	18,704
1957	71,180	220,214	48,205	152,964	29,727	21,866
1958	79,429	203,306	45,916	175,535	46,604	22,368
1959	93,483	276,688	42,276	173,401	48,647	22,310
1960	97,541	232,754	36,062	187,940	60,979	26,681
1961	105,974	233,350	43,289	191,816	51,204	28,712
1962	105,034	236,507	45,366	200,601	49,420	31,927
1963	112,176	234,654	38,264	274,720	54,641	30,524
1964	123,482	254,072	43,725	287,711	65,187	39,638
1965	132,708	232,721	44,813	328,232	59,317	38,268
1966	131,014	272,061	45,758	306,020	63,381	43,161
1967	136,644	245,566	50,646	333,208	69,890	48,054
1968*	139,900	294,211	50,115	342,391	92,695	45,874

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-19

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Colorado 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	.3, 490	10	5, 493	2, 158	87	178
1955	2, 636	527	7, 032	2, 812	0	556
1956	2, 614	0	10, 390	3, 691	785	1, 384
1957	3, 896	0	12, 175	3, 091	913	2, 774
1958	5, 896	602	23, 583	4, 062	1, 145	2, 099
1959	6, 338	1, 189	24, 374	5, 410	2, 699	2, 132
1960	9, 250	80	23, 767	5, 021	3, 816	2, 159
1961	4, 979	0	28, 896	5, 337	3, 344	2, 565
1962	10, 904	370	32, 032	4, 577	4, 068	2, 356
1963	7, 692	290	33, 392	6, 025	2, 456	3, 619
1964	12, 443	22	41, 590	7, 502	4, 303	4, 882
1965	11, 026	81	40, 871	9, 343	5, 364	5, 017
1966	24, 044	304	41, 817	10, 107	4, 483	4, 974
1967	26, 372	1, 485	43, 637	12, 325	11, 001	4, 017
1968*	37, 220	183	44, 877	10, 004	15, 330	2, 532

* 1968 figures are preliminary

Source: U. S. , Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C. : Government Printing Office, 1954-1968).

TABLE D-20

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Idaho 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	1,539	0	13,754	19,227	0	40
1955	3,960	1,869	20,185	31,463	1	170
1956	4,492	3,495	6,949	9,691	21	485
1957	3,041	9,629	11,114	10,593	245	411
1958	6,142	14,095	17,912	17,371	498	401
1959	5,120	17,971	21,153	21,498	2,109	428
1960	6,121	13,699	23,574	14,922	1,974	700
1961	10,510	23,139	21,871	16,617	6,697	1,451
1962	10,706	24,469	22,245	16,928	6,998	1,477
1963	10,759	11,487	27,175	28,663	8,023	5,353
1964	11,958	13,453	31,199	38,836	8,907	7,051
1965	10,247	14,181	31,883	50,165	18,546	8,635
1966	8,920	14,295	37,878	64,895	19,753	6,904
1967	11,621	17,575	40,552	56,874	24,751	10,421
1968*	15,679	13,226	47,053	69,792	25,738	11,547

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-21

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Iowa 1954 - 1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	21,039	0	49,140	4,907	9,401	4,649
1955	17,882	0	54,504	1,159	11,126	1,429
1956	10,523	642	27,922	444	5,617	1,946
1957	15,009	1,308	33,486	468	9,432	1,374
1958	18,114	777	49,526	3,900	18,331	591
1959	30,090	218	68,131	5,421	28,588	1,118
1960	31,187	76	67,606	4,416	45,984	1,087
1961	40,484	0	73,899	8,688	90,018	1,928
1962	55,105	21,430	78,430	3,838	108,026	3,938
1963	97,674	59,463	75,443	1,494	147,416	4,502
1964	139,678	95,046	84,583	1,868	136,628	4,180
1965	181,573	116,487	73,077	2,182	147,748	4,154
1966	260,870	139,781	57,024	3,515	170,131	4,873
1967	404,414	136,831	105,089	2,380	152,917	7,280
1968*	511,876	153,243	103,650	2,546	171,331	8,183

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-22

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Minnesota 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	5,882	0	13,249	1,046	4,295	212
1955	15,474	0	10,608	1,967	8,457	87
1956	13,694	0	6,811	449	5,506	526
1957	12,503	88	8,820	266	10,650	497
1958	19,573	0	15,433	387	14,551	444
1959	18,761	907	24,182	783	28,742	227
1960	7,062	623	19,516	1,957	22,116	492
1961	10,349	785	19,471	565	38,885	481
1962	15,050	900	18,198	235	43,148	857
1963	19,800	9,263	19,574	818	56,305	1,079
1964	17,129	2,443	24,922	848	52,902	1,339
1965	20,145	4,647	32,368	5,978	47,119	2,380
1966	29,904	15,984	36,803	2,000	39,449	2,902
1967	102,439	16,798	49,990	635	64,796	2,432
1968*	167,610	17,000	69,560	1,153	74,361	3,275

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-23

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Montana 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	0	0	5,260	2,735	0	0
1955	225	0	3,030	1,154	0	61
1956	1,088	0	2,910	2,699	102	221
1957	1,963	352	6,000	3,192	161	149
1958	1,574	407	4,127	483	259	109
1959	1,406	194	5,303	701	45	11
1960	1,641	565	6,707	511	44	52
1961	3,047	263	7,072	154	50	0
1962	1,290	1,010	7,918	445	83	57
1963	1,703	1,144	7,174	583	69	370
1964	1,033	278	5,748	394	574	56
1965	889	54	5,713	507	1,384	232
1966	1,404	472	8,475	1,795	3,753	201
1967	1,899	342	12,614	1,912	4,808	352
1968*	2,500	889	16,753	2,500	6,000	350

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-24

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Nebraska 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	25,294	0	40,754	4,045	13,958	3,991
1955	22,766	101	68,604	544	13,714	2,059
1956	36,153	498	30,013	312	11,291	2,667
1957	45,508	1,458	35,208	2,134	18,745	3,878
1958	68,517	8,219	52,492	1,827	35,043	1,668
1959	80,914	12,306	66,727	1,686	57,121	2,294
1960	83,627	15,333	59,537	881	73,522	1,900
1961	135,403	22,428	85,064	1,452	110,158	3,876
1962	124,712	17,518	74,946	1,102	101,745	4,793
1963	150,717	21,778	75,626	2,438	100,532	4,205
1964	157,844	14,834	82,499	3,387	77,665	5,733
1965	171,634	16,859	84,667	2,369	96,402	7,623
1966	234,631	19,017	102,238	3,352	110,892	10,798
1967	248,287	16,144	123,036	3,543	118,340	10,207
1968*	326,268	16,818	136,197	4,510	143,653	10,952

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-25

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Nevada 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	0	0	148	405	256	30
1955	10	40	6	254	0	8
1956	14	96	48	632	20	27
1957	35	412	241	907	30	22
1958	162	330	307	545	121	60
1959	315	478	101	461	108	32
1960	647	368	215	385	71	60
1961	503	606	218	935	30	155
1962	683	647	396	680	206	138
1963	956	86	246	897	0	197
1964	835	23	417	632	56	135
1965	814	229	406	662	25	217
1966	1,325	716	277	1,176	24	180
1967	1,423	196	151	1,046	20	420
1968*	1,118	55	259	1,651	20	439

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-26

Consumption of Selected Nitrogen Materials By Direct Application
In the State of North Dakota 1954 - 1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	30	0	425	70	0	0
1955	134	0	579	87	141	34
1956	102	0	947	20	64	42
1957	235	0	1,101	85	49	73
1958	555	0	2,071	32	43	40
1959	1,026	15	3,464	130	253	30
1960	2,995	0	3,426	35	485	30
1961	3,601	2	4,625	167	2,417	53
1962	1,390	43	9,295	980	2,767	69
1963	2,202	0	5,181	914	2,224	50
1964	1,238	0	10,981	238	1,838	58
1965	1,204	0	11,128	59	3,132	16
1966	1,355	0	17,077	0	5,231	18
1967	1,686	0	21,922	466	9,670	127
1968*	4,334	0	41,780	384	15,006	2,365

* 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-27

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Oregon 1954 - 1968

Year	Ammonia		Ammonium		Nitrate Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	3, 598	187	23, 558	36, 760	50	1, 040
1955	7, 069	1, 745	26, 769	42, 166	1, 582	1, 672
1956	5, 353	11, 552	22, 582	38, 666	915	2, 631
1957	6, 023	29, 266	26, 062	43, 524	10, 468	4, 009
1958	7, 901	31, 064	25, 923	37, 226	4, 182	3, 701
1959	9, 954	30, 374	28, 475	39, 388	1, 798	3, 489
1960	5, 098	26, 229	19, 619	38, 857	3, 620	7, 198
1961	5, 335	33, 875	19, 696	46, 159	8, 012	9, 498
1962	5, 422	30, 779	14, 243	52, 909	6, 310	15, 847
1963	5, 960	34, 057	15, 901	69, 122	7, 844	19, 685
1964	8, 608	30, 625	10, 386	74, 586	6, 856	19, 061
1965	8, 919	33, 401	11, 993	77, 342	12, 713	24, 010
1966	10, 828	31, 191	12, 202	87, 392	12, 876	30, 357
1967	16, 474	28, 117	15, 326	117, 435	15, 873	36, 668
1968*	14, 718	31, 715	14, 429	115, 000	14, 759	35, 000

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-28

Consumption of Selected Nitrogen Materials By Direct Application
In the State of South Dakota 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	1,357	0	3,103	403	171	139
1955	1,695	0	4,680	168	394	269
1956	1,618	0	2,455	7	319	394
1957	654	0	2,535	55	44	192
1958	1,374	382	5,941	80	620	105
1959	1,387	436	8,613	43	1,291	359
1960	1,097	800	6,870	116	1,804	268
1961	1,021	1,439	10,752	18	4,916	399
1962	1,193	1,082	16,195	64	2,197	1,663
1963	1,459	2,799	21,094	583	1,670	1,187
1964	1,676	639	23,268	2,164	4,049	908
1965	3,779	379	21,012	3,208	6,063	545
1966	8,987	1,145	29,552	5,829	7,457	2,593
1967	10,627	900	43,082	3,744	7,127	415
1968*	13,006	1,072	48,519	5,872	20,625	614

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-29

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Utah 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	1,058	0	4,487	8,085	16	2
1955	1,675	2	5,636	4,617	0	98
1956	1,821	0	6,138	5,781	22	564
1957	1,254	0	5,314	5,024	398	447
1958	2,088	246	10,090	6,108	0	388
1959	1,484	125	9,493	4,810	18	277
1960	447	197	11,971	5,189	13	288
1961	621	178	11,365	6,587	203	462
1962	1,358	7	8,214	3,218	142	1,141
1963	5,092	152	5,797	4,405	64	1,299
1964	1,969	3,347	9,030	6,215	100	2,031
1965	3,526	1,014	8,667	9,365	65	1,695
1966	1,200	157	6,678	12,441	471	1,403
1967	172	78	7,660	9,300	1,260	880
1968*	260	75	8,681	10,600	1,300	900

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-30

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Washington 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	14,708	2,923	32,557	32,334	620	1,427
1955	18,289	20,761	33,981	32,573	1,175	890
1956	19,013	27,108	22,019	12,373	1,645	1,372
1957	23,137	36,023	22,306	11,295	5,621	1,209
1958	36,926	55,270	30,475	13,243	5,596	975
1959	37,025	59,123	23,392	14,974	4,505	1,949
1960	40,801	65,006	24,202	17,797	14,468	3,777
1961	29,949	44,370	19,304	17,092	20,047	3,069
1962	33,679	60,921	28,132	24,449	32,438	5,739
1963	44,930	76,127	27,819	32,281	36,473	12,654
1964	47,870	77,948	33,534	29,680	23,414	12,528
1965	57,306	71,684	34,321	29,125	29,891	17,469
1966	55,117	75,131	39,988	38,778	41,032	12,946
1967	61,672	80,173	51,679	46,313	42,655	18,001
1968*	63,367	85,449	50,401	46,408	41,072	24,262

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-31

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Wisconsin 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	1,948	0	8,652	154	279	232
1955	2,815	0	7,069	239	315	101
1956	3,346	0	5,836	239	1,071	234
1957	3,317	369	6,052	227	1,877	391
1958	5,123	195	5,707	826	4,499	154
1959	4,675	263	8,714	1,341	4,640	335
1960	3,391	214	6,162	1,100	4,630	271
1961	5,569	97	7,980	1,893	8,642	1,900
1962	5,153	54	7,186	1,747	10,244	2,743
1963	3,794	313	9,558	1,338	15,641	2,120
1964	8,080	8,123	10,341	316	18,432	2,082
1965	10,101	5,180	14,123	868	27,221	1,941
1966	15,792	4,945	16,108	1,565	34,487	1,763
1967	26,238	3,579	19,781	1,061	51,850	3,022
1968*	59,257	8,337	27,431	517	54,913	3,203

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-32

Consumption of Selected Nitrogen Materials By Direct Application
In the State of Wyoming 1954-1968

Year	Ammonia		Ammonium		Nitrogen Solutions	Urea
	Anhydrous	Aqua	Nitrate	Sulphate		
	tons	tons	tons	tons	tons	tons
1954	250	0	1,049	477	0	139
1955	206	0	848	299	0	238
1956	900	34	842	422	0	362
1957	1,115	0	1,418	288	16	342
1958	1,003	0	3,350	632	4	525
1959	1,013	276	3,385	629	688	530
1960	1,008	297	3,865	658	1,125	495
1961	1,260	0	3,791	245	939	459
1962	1,173	55	3,530	269	874	527
1963	1,984	100	5,658	869	913	693
1964	675	0	8,008	567	1,065	387
1965	1,795	422	10,958	1,182	811	44
1966	1,847	389	13,705	1,811	1,807	182
1967	1,681	453	16,422	1,630	2,168	214
1968*	1,173	574	18,064	1,300	2,276	616

* 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-33

Consumption of Phosphate and Potash Materials
In the State of Arizona 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	4,868	4,110	20,414	36
1955	5,328	4,615	25,175	508
1956	5,174	3,395	25,817	182
1957	5,414	3,754	27,972	52
1958	6,648	3,063	36,178	100
1959	5,852	3,144	38,909	202
1960	6,420	3,368	35,657	94
1961	9,629	3,297	32,325	920
1962	5,318	2,035	29,833	220
1963	3,359	2,675	33,069	121
1964	3,337	2,059	36,929	140
1965	2,471	2,741	35,425	38
1966	2,777	2,710	29,299	279
1967	1,584	2,938	40,756	382
1968**	1,266	2,329	47,094	393

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-34

Consumption of Phosphate and Potash Materials
In the State of California 1954-1968

Year	Superphosphates: Grades 22% and Under	Superphosphates: Grades Over 22%	Ammoniated Phosphates*	Potash Materials: Chlorides 50%-62% Grades
	(tons)			
1954	51,948	11,615	69,639	1,300
1955	61,474	14,541	68,092	1,268
1956	64,215	17,569	86,931	1,896
1957	61,332	16,600	83,857	2,149
1958	58,537	18,857	86,600	1,411
1959	75,350	17,933	86,973	1,398
1960	98,213	15,283	92,965	1,920
1961	92,675	14,915	101,199	3,013
1962	85,176	13,469	105,857	1,976
1963	84,556	9,429	115,766	2,264
1964	86,688	11,437	132,338	3,263
1965	82,276	9,724	139,930	2,917
1966	73,306	8,638	137,504	4,691
1967	72,459	8,653	140,242	9,223
1968**	77,144	9,149	138,686	8,021

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-35

Consumption of Phosphate and Potash Materials
In the State of Colorado 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	1,653	14,043	243	170
1955	720	13,926	2,987	200
1956	793	13,826	3,276	430
1957	1,258	14,493	4,657	437
1958	167	14,122	6,246	388
1959	95	16,221	7,425	434
1960	2,870	14,697	8,670	391
1961	1,006	18,073	11,032	415
1962	72	17,039	11,574	594
1963	100	18,318	8,460	1,161
1964	546	18,856	8,105	2,095
1965	106	26,088	7,202	1,809
1966	391	21,680	7,915	3,393
1967	749	18,556	10,499	5,672
1968**	821	19,916	8,348	8,531

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-36

Consumption of Phosphate and Potash Materials
In the State of Idaho 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	12,664	18,475	10,987	85
1955	16,267	14,659	6,916	114
1956	3,002	16,146	7,756	129
1957	2,558	17,743	11,768	218
1958	661	19,977	13,643	952
1959	83	24,842	16,533	726
1960	932	24,425	26,115	71
1961	2,245	22,922	27,073	726
1962	1,769	19,442	19,947	673
1963	1,113	19,303	18,289	649
1964	1,596	32,288	25,120	1,632
1965	1,111	28,188	21,635	1,278
1966	936	34,706	30,007	2,800
1967	686	37,495	27,813	4,951
1968**	709	33,289	25,656	3,567

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-37

Consumption of Phosphate and Potash Materials
In the State of Iowa 1954-1968

Year	Superphosphates: Grades 22% and Under	Superphosphates: Grades Over 22%	Ammoniated Phosphates*	Potash Materials: Chlorides 50%-62% Grades
	(tons)			
1954	52,272	10,670	25,989	6,739
1955	43,262	23,226	21,720	12,141
1956	33,159	20,507	13,434	9,075
1957	37,498	22,099	10,321	9,528
1958	32,182	31,738	15,316	13,865
1959	36,056	32,799	17,488	16,965
1960	23,266	31,612	18,203	14,459
1961	22,893	40,647	18,916	14,378
1962	23,699	48,300	15,885	21,647
1963	26,532	61,178	16,702	39,395
1964	27,054	102,004	14,911	71,494
1965	23,197	110,829	7,820	94,733
1966	31,212	157,819	9,010	135,741
1967	31,762	191,627	6,402	231,148
1968**	28,843	204,757	6,097	265,791

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizer in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-38

Consumption of Phosphate and Potash Materials
In the State of Minnesota 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	10,796	17,673	3,249	1,346
1955	7,286	28,610	8,190	2,243
1956	4,378	25,834	7,592	3,718
1957	6,502	29,744	13,423	8,615
1958	4,950	25,691	19,229	12,044
1959	5,453	20,583	23,851	13,682
1960	14,292	23,695	26,262	10,965
1961	4,602	24,653	29,864	15,746
1962	5,494	27,244	23,216	18,424
1963	3,987	26,394	21,267	23,933
1964	8,476	32,105	23,082	33,449
1965	11,035	62,145	18,010	48,041
1966	17,343	68,218	23,010	62,145
1967	11,931	74,492	13,223	128,860
1968**	11,850	74,854	11,934	166,938

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-39

Consumption of Phosphate and Potash Materials
In the State of Montana 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
		(tons)		
1954	10	13,354	2,780	10
1955	176	12,448	2,999	24
1956	90	16,078	4,085	62
1957	40	19,425	6,956	50
1958	0	18,746	5,676	41
1959	0	18,252	9,811	31
1960	0	16,831	11,681	6
1961	0	17,563	14,763	23
1962	0	17,474	13,860	10
1963	0	19,830	15,628	144
1964	0	18,717	17,650	198
1965	0	17,935	19,169	346
1966	0	19,028	30,186	518
1967	0	20,040	50,633	680
1968**	0	25,000	54,680	1,445

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-40

Consumption of Phosphate and Potash Materials
In the State of Nebraska 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	4,498	17,052	10,164	128
1955	4,619	24,682	13,871	213
1956	2,492	17,994	9,193	264
1957	1,886	24,906	9,742	393
1958	1,634	17,948	10,295	271
1959	1,285	19,119	14,111	386
1960	1,390	17,493	16,287	479
1961	3,984	28,624	20,746	1,221
1962	4,135	27,722	21,921	1,714
1963	6,428	27,386	17,572	2,346
1964	8,959	24,403	21,229	4,328
1965	13,098	24,542	12,692	5,617
1966	18,733	32,938	14,754	9,389
1967	26,406	43,009	14,906	20,708
1968**	28,119	46,036	13,512	30,763

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-41

Consumption of Phosphate and Potash Materials
In the State of Nevada 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
	(tons)			
1954	154	544	854	3
1955	52	407	245	2
1956	40	297	733	0
1957	3	339	810	0
1958	0	838	1,147	14
1959	1	479	1,018	3
1960	0	416	696	0
1961	0	572	1,263	0
1962	22	570	1,856	0
1963	31	841	1,893	0
1964	52	834	1,980	0
1965	124	1,151	2,370	0
1966	8	1,176	2,089	0
1967	23	1,656	3,569	0
1968**	176	1,000	2,715	0

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-42

Consumption of Phosphate and Potash Materials
In the State of North Dakota 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
		(tons)		
1954	90	14,919	8,380	14
1955	127	19,555	18,196	52
1956	30	17,598	26,317	22
1957	50	17,770	32,177	25
1958	13	17,758	55,140	2
1959	70	18,268	68,829	7
1960	15	25,638	60,996	73
1961	0	30,160	63,446	50
1962	646	32,017	68,003	112
1963	0	27,173	63,255	126
1964	0	35,993	67,597	539
1965	856	35,746	67,088	598
1966	904	40,015	80,029	1,645
1967	0	42,085	86,790	2,621
1968**	0	30,337	79,359	4,520

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-43

Consumption of Phosphate and Potash Materials
In the State of Oregon 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
		(tons)		
1954	11,774	2,856	21,778	1,436
1955	11,568	2,720	25,819	1,419
1956	10,573	843	25,862	2,730
1957	10,623	1,030	31,982	1,714
1958	7,615	1,450	24,762	1,689
1959	9,270	2,117	25,884	1,570
1960	9,666	1,672	39,084	1,995
1961	9,680	2,327	34,734	2,094
1962	11,788	1,547	34,096	2,898
1963	11,008	1,706	37,207	2,841
1964	14,177	1,992	47,446	3,406
1965	12,834	7,176	46,687	5,576
1966	13,918	6,084	64,072	9,728
1967	16,736	18,689	67,411	10,996
1968**	17,573	19,810	73,448	11,050

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-44

Consumption of Phosphate and Potash Materials
In the State of South Dakota 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
		(tons)		
1954	1,841	4,997	3,680	13
1955	707	7,302	5,625	13
1956	571	4,912	6,342	31
1957	517	4,301	5,908	6
1958	195	5,259	8,994	22
1959	239	6,222	7,969	57
1960	154	4,766	7,125	34
1961	105	5,495	10,224	40
1962	205	6,789	14,519	333
1963	250	8,242	14,252	571
1964	276	9,140	12,280	1,653
1965	462	9,661	8,786	1,507
1966	1,463	12,508	14,241	3,458
1967	730	16,401	21,103	5,673
1968**	271	14,289	14,829	6,672

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-45

Consumption of Phosphate and Potash Materials
In the State of Utah 1954-1968

Year	Superphosphates		Ammoniated Phosphates*	Potash Materials
	Grades 22% and Under	Grades Over 22%		Chlorides 50%-62% Grades
	(tons)			
1954	4,031	4,854	1,445	38
1955	3,034	6,269	1,174	73
1956	1,944	5,569	2,524	30
1957	3,087	6,603	2,883	52
1958	2,395	8,397	3,696	54
1959	2,151	7,317	2,867	62
1960	3,231	7,294	3,346	66
1961	3,204	7,433	3,325	35
1962	2,682	10,103	3,494	28
1963	2,073	4,506	3,178	88
1964	2,276	8,710	3,162	139
1965	2,287	10,627	6,967	309
1966	2,565	20,666	12,988	224
1967	1,980	16,002	12,172	150
1968**	2,100	15,500	12,550	175

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-46

Consumption of Phosphate and Potash Materials
In the State of Washington 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
		(tons)		
1954	8,595	7,678	15,090	2,431
1955	8,817	8,537	13,688	2,354
1956	5,868	7,565	13,046	2,485
1957	4,551	6,029	12,200	2,042
1958	5,772	7,221	24,908	2,929
1959	4,417	7,720	22,931	4,062
1960	4,659	4,997	24,848	4,630
1961	4,390	5,614	27,000	4,936
1962	4,615	8,370	36,872	6,864
1963	4,881	9,294	34,285	6,185
1964	5,271	11,063	43,379	7,324
1965	4,420	9,831	30,390	11,000
1966	4,807	12,731	39,629	9,774
1967	3,622	15,622	40,144	14,999
1968**	3,741	18,609	43,676	18,528

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

TABLE D-47

Consumption of Phosphate and Potash Materials
In the State of Wisconsin 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
	(tons)			
1954	2,810	135	50	3,943
1955	2,289	564	162	3,860
1956	1,997	882	301	6,470
1957	2,371	1,808	786	8,764
1958	1,844	1,332	371	10,219
1959	2,912	1,705	479	16,785
1960	3,313	1,607	1,393	16,163
1961	1,567	2,404	2,070	28,605
1962	1,842	3,648	735	32,310
1963	1,682	3,113	692	38,645
1964	3,376	6,589	1,182	55,444
1965	4,036	12,609	744	77,881
1966	4,502	17,283	1,051	101,230
1967	4,437	26,589	635	142,231
1968**	5,589	39,414	351	201,957

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U. S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D. C.: Government Printing Office, 1954-1968).

TABLE D-48

Consumption of Phosphate and Potash Materials
In the State of Wyoming 1954-1968

Year	Superphosphates			Potash Materials
	Grades 22% and Under	Grades Over 22%	Ammoniated Phosphates*	Chlorides 50%-62% Grades
	(tons)			
1954	315	4,754	680	0
1955	342	5,339	568	36
1956	25	5,285	1,129	27
1957	0	4,478	1,202	31
1958	50	4,047	1,465	6
1959	0	4,814	2,203	29
1960	38	4,922	3,480	22
1961	0	3,896	2,565	21
1962	0	3,969	3,739	9
1963	0	4,794	2,840	118
1964	0	5,236	2,895	112
1965	3	5,101	3,134	36
1966	8	7,082	3,087	309
1967	0	8,151	3,633	619
1968**	0	7,402	3,768	848

* Total of 11-48-0, 13-39-0, 16-20-0, 21-53-0 and 27-14-0 grades

** 1968 figures are preliminary

Source: U.S., Department of Agriculture, Statistical Reporting Service, Consumption of Commercial Fertilizers in the United States (Washington, D.C.: Government Printing Office, 1954-1968).

APPENDIX E

EXPORTS OF FERTILIZERS FROM CANADA

APPENDIX E

LIST OF TABLES

TABLE E-1

Exports of Ammonium Nitrate From Canada
1964 - 1968

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
Ammonium Nitrate	416-44					
United Kingdom		0.2	-	-	-	-
Ghana		0.1	-	-	2.0	-
Sierra Leone		0.6	-	-	-	-
Liberia		18.4	-	-	-	-
Columbia		3.3	-	-	-	-
Peru		127.6	-	-	280.0	337.0
Bahamas		3.2	-	2.0	-	-
Cuba		531.4	-	-	-	-
Neth. Antilles		2.4	1.8	12.0	17.0	-
St. Pierre		4.9	3.5	-	-	-
Surinam		-	3.6	6.0	12.0	-
Honduras		-	3.9	-	1.0	-
Nicaragua		-	1.8	3.0	7.0	-
Australia		-	-	-	334.0	447.0
Tunisia		-	-	-	-	318.0
United States		10,319.5	10,181.9	8,980.0	9,003.0	11,097.0
Total		11,011.6	10,196.5	9,003.0	9,656.0	12,199.0

Source: Canada, Dominion Bureau of Statistics, Trade of Canada Exports, Summary of Annual Reports 1964-1968, Catalogue No. 65-004 (Ottawa: Queen's Printer, 1954-1968).

TABLE E-2

Exports of Urea and Nitrogen Solutions From Canada
1964 - 1968

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
Urea and Nitrogen Solutions	416-45					
United Kingdom		210.0	10.9	6.0	13.0	22.0
Pakistan		0.2	-	-	-	848.0
Nicaragua		4.1	0.2	1.0	-	-
Switzerland		-	0.3	-	1.0	-
Yugoslavia		-	0.9	3.0	-	-
Zambia		-	0.6	-	-	-
Australia		-	112.2	-	-	13.0
Peru		-	0.6	-	-	-
Leew-Wind Island		-	0.1	-	-	-
Cuba		-	21.5	-	-	-
Venezuela		-	-	1.0	-	-
Mexico		-	-	7.0	13.0	12.0
Netherlands		-	-	-	1.0	1.0
India		-	-	-	2,186.0	3,963.0
United States		15,304.7	14,749.0	13,824.0	13,581.0	14,008.0
Total		15,519.0	14,896.3	13,841.0	15,795.0	18,767.0

Source: Canada, Dominion Bureau of Statistics, Trade of Canada Exports, Summary of Annual Reports 1964-1968, Catalogue No. 65-004 (Ottawa: Queen's Printer, 1954-1968).

TABLE E-3

Exports of Nitrogen Phosphate, Ammonium Sulphate and Prepared Fertilizer Mixtures From Canada
1964 - 1968

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
Nitrogen Phosphate Fertilizers	416-47					
Cuba		12.1	-	-	-	-
Malaysia		-	-	7.0	-	-
India		-	-	-	-	1,368.0
United States		10,243.6	19,457.0	22,782.0	26,596.0	24,397.0
Total		10,255.7	19,457.0	22,789.0	26,596.0	25,765.0
Ammonium Sulphate	416-48					
Pakistan		688.7	330.0	-	-	-
Australia		390.0	843.8	904.0	34.0	56.0
India		-	1,286.2	1,482.0	-	2,760.0
Philippines		-	85.5	-	-	-
United States		4,978.7	6,395.3	5,897.0	6,707.0	5,006.0
Total		6,057.4	9,740.8	7,283.0	6,741.0	7,822.0

TABLE E-3 continued

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
Prepared Fertilizer Mixtures	416-49					
France		-	-	1.0	-	-
Netherlands		8.5	17.7	19.0	-	11.0
Norway		-	-	1.0	-	-
Bahamas		0.1	-	-	-	-
Ghana		-	-	3.0	-	-
Bermuda		13.6	9.6	15.0	12.0	14.0
Leew-Wind Island		-	-	-	-	33.0
Cuba		6,028.2	-	-	-	-
Israel		-	-	-	-	11.0
Neth. Antilles		0.5	-	-	-	1.0
United Kingdom		-	0.3	-	-	-
Trinidad		-	1.4	3.0	-	-
United States		9,380.2	3,756.1	6,045.0	5,871.0	5,253.0
Total		15,431.1	3,785.1	6,087.0	5,883.0	5,325.0

Source: Canada, Dominion Bureau of Statistics, Trade of Canada Exports, Summary of Annual Reports 1964-1968, Catalogue No. 65-004 (Ottawa: Queen's Printer, 1954-1968).

TABLE E-4

Exports of Fertilizers and Fertilizer Material N. E. S.
From Canada 1964-1968

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
Fertilizers and Fertilizer Materials N. E. S.	416-99					
Peru		(1)	-	-	14.7	-
West Germany		(1)	-	-	-	-
Israel		(1)	-	-	32.0	5.0
Cyprus		-	-	-	-	1.0
Liberia		(1)	-	-	-	-
Japan		(1)	(1)	-	-	-
Philippines		(1)	(1)	-	-	-
Columbia		-	-	-	-	1.0
Taiwan		(1)	(1)	-	-	-
New Zealand		(1)	(1)	-	-	-
Brazil		(1)	(1)	-	-	-
Venezuela		-	-	-	-	1.0
Bermuda		(1)	(1)	4.0	7.0	15.0
British Honduras		(1)	-	-	-	-
Jamaica		(1)	-	-	-	-
Cuba		(1)	-	-	-	-

TABLE E-4 continued

Fertilizer and Country of Import	Export Class No.	1964	1965	1966	1967	1968
		$'000	$'000	$'000	$'000	$'000
United Kingdom		-	(1)	12.0	296.0	4.0
Finland		-	(1)	-	-	-
France		-	(1)	-	44.0	4.0
Netherlands		-	(1)	6.0	11.0	9.0
Zambia		-	(1)	-	-	-
Australia		-	(1)	7.0	14.0	-
Bahamas		-	(1)	-	-	-
Leew-Wind Island		-	(1)	-	-	-
Trinidad		-	(1)	-	-	-
Costa Rica		-	(1)	-	-	-
Guatamala		-	(1)	-	-	-
Neth. Antilles		-	(1)	-	-	-
Mexico		-	-	11.0	30.0	10.0
Spain		-	-	-	1.0	-
Republic of S. Africa		-	-	-	1.0	2.0
El Salvador		-	-	-	-	5.0
United States		(1)	(1)	3,100.0	3,363.0	2,661.0
Total		(1)	(1)	3,140.0	3,754.0	2,719.0

Notes: (1) Prior to 1966, muriate of potash was included in this category.
N.E.S. - not elsewhere specified in export statistics.

Source: Canada, Dominion Bureau of Statistics, Trade of Canada Export, Summary of Annual Reports 1964-1968, Catalogue No. 65-004 (Ottawa: Queen's Printer, 1954-1968).

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